ACTA MEDICA SCANDINAVICA

SUPPLEMENTUM I

THE EFFECTS OF ALCOHOL UPON DIGESTION IN THE STOMACH

BY

AKSEL O. HANEBORG

PRINTED BY GRØNDAHL & SØN CHRISTIANIA 1921

Paa grundlag av nærværende avhandling er forfatteren kreert til doctor medicinae 29/10-21.

ved Det Kongelige Frederiks Universitet i Kristiania.

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CONTENTS

Introduction . . . .

Chapt. I. Analytical method 1

Recovered of the contents of the stomach and flushing of the latter 2

Determination of the free and combined hydrochloric acid, the total acidity and the hydrogen-ion-concentration 4

Determination of the proteolytic capacity of the gastric juice 9

Determination of alcohol 13

Determination of tartaric acid and tartar in claret and rhenish wine 19

» II. The effects of alcohol upon resorption and secretion in the digestive canal, with special reference to the stomach 20

» III. The influence of alcohol upon the proteolytic effects of the natural contents of the stomach . . . 38

» IV. The relation of alcohol to the secretion in the stomach and the composition of the contents of the stomach, with direct effects in the stomach 44

1. Test meals with and without alcohol 46

2. The effects of alcohol upon diseases of the stomach 54

a) Ulcus ventriculi 55

b) Cancer ventriculi 58

c) Dyspepsia 60

d) Achylia gastrica 65

3. Investigations concerning the effects of considerable doses of alcohol upon the secretion of gastric juice in healthy individuals 69

» V. The effects of alcohol upon »psychic« secretion . . 73

» VI. The influence of alcohol upon the motor functions of the stomach 82

» VII. Experiments with wine and beer 91

» VIII. Resumé and discussion of the results of the experiments 107

1. The effects of alcohol upon conditions of resorption 107
2. The influence of alcohol upon the proteolytic effects of natural gastric contents in vitro . . . 110
3. The relation of alcohol to secretion 111
4. The effects of alcohol upon the psychic secretion of gastric juice 113
5. The influence of alcohol upon the motor functions of the stomach 113
6. The effects of beer and wine upon gastric digestion 113
7. The effects of alcohol with a pathological condition of the stomach 114

Bibliography 118

PREFACE

The clinical experiments with various patients and convalescents mentioned in this thesis were carried out at the medical section of the Christiania Municipal Hospital, under my former master Dr. *H. J. Vetlesen,* M. D., Senior Physician, whom I hereby convey my special thanks.

The continued experiments were carried out at the medical Policlinic of the Riks Hospital, by kind permission of Professor *S. Laache,* M. D.

The other experiments and special physiological-chemical investigations were carried out at the University Physiological Institute, the principal of which Professor *S. Torup.* M. D. has with never failing interest helped me with advice. I hereby offer him my most sincere thanks.

Christiania, May 1921.

Aksel O. Haneborg.

INTRODUCTION.

The object of the investigations of which an account will be given in the following pages is to offer a contribution towards an understanding of the effects of alcohol upon a number of processes which take place in the stomach during the presence of food in the latter.

It is quite true that there has been no lack of research in this direction. From ancient times alcohol was renowned as a »stomachicum« that was able to promote and facilitate digestion.

Most of the earlier investigators, however, restricted themselves for the most part to an examination of the effects of alcohol upon the proteolysis of the pepsin. This is of course a matter of great importance, but it is nevertheless only one individual factor. For indeed, digestion is not merely dependent upon this purely chemical process, but also depends upon the nature of the secretion, both of the qualitative composition and quantity of the gastric juice which is secreted. In addition there is the circumstance that the conditions of evacuation of the stomach undoubtedly play a vital part both in the purely objective result of the treatment of the food and also as regards the subjective condition of the body during digestion. The incompleteness of the earlier investigations becomes still more striking when we notice that the great majority of these investigations were carried out with preparations of pepsin which are on the market, and carried out with more or less haphazard preparations of concentrated hydrochloric acid, even though they may have been close to the normal, and in glass. If we are to draw conclusions with regard to the effects of alcohol upon digestion, the investigations must naturally approach as closely as possible to the actual conditions present, and must deal with all the factors which have influence upon them. We should first and foremost investigate the relation of alcohol to the secretion itself both in a qualitative and quantitative respect, and next the course of digestion in the stomach itself, and finally the conditions of evacuation of that organ.

For an understanding of the results of digestion in the stomach, it will be necessary to investigate the effects of the *natural* contents of the stomach upon proteolysis in vitro and the *conditions of resorption* of alcohol in the stomach.

The investigations have been laid so close to the physiological and practical conditions occurring in ordinary life in order that they may be of greater value for the understanding of the alcohol question on the whole. In addition, experiments have also been made with various patients in order to find the effects of alcohol upon a diseased condition of the stomach.

The investigations therefore fall into the following sections: —

I. Analytical method.

II. The resorption of alcohol from stomach and intestines.

III. The effect of alcohol upon digestion with the natural contents of the stomach in vitro.

IV. The relation of alcohol to the secretion in the stomach and the composition of the contents of the stomach, with direct effect upon the latter.

V. The effects of alcohol upon psychical secretion.

VI. The effects of alcohol upon the conditions of evacuation of the stomach.

VII. Investigations of the effects of ale and wine upon the processes of secretion in the stomach and the evacuation of the latter.

VIII. Discussion of results, and résumé.

I. Analytical Methods.

Before proceeding to deal with the special investigations and their results, we will give a general survey of the methods of procedure and the analytical methods employed in order to avoid repetition and interruptions.

As test meals there were at times employed those generally known to medical literature and at others such as were composed with a view to the special objects of these investigations.

As regards the special meals, an account will be given of each experiment at which they were employed. As regards the others, *Ewald's test breakfast* was employed in the following combinations:

> 250 ccms of warm water and one roll of wheaten bread weight 40 grammes. Time of meal 10 min. Instead of a roll, 40 grammes of wheaten bread were now and then employed.
>
> For a BOURGET-FABER meal there were employed: 250 grammes of oatmeal gruel, 50 grammes of minced and boiled veal, 80 grammes of wheaten bread, buttered, eight boiled prunes and two tablepoons of cranberry preserve. Time of meal fifteen minutes. In the experiment with *claret* and *Rhenish wine* there were employed for Bourget's meal: 150 grammes medium thick oatmeal gruel, the water (100 ccms) being removed, and instead there are given *100 grammes claret* or *100 grammes Rhenish wine* respectively. Otherwise the same constituent parts. In the experiment with ale, there were given: 25 grammes of *oatmeal porridge* (with corresponds to 250 grammes of gruel) and 225 grammes of ale.

Recovery of the contents of the stomach and flushing of the latter.

For the recovery of the *entire* contents of the stomach there was employed an ordinary stomach pump, and for pumping a *Senoran* flask.

For the recovery of small tests from the contents of the stomach and intestines respectively there was employed a *Rehfuss* probe, a quite thin stomach-intestine probe in which is placed a small pierced metal olive. For pumping, a small glass syringe was employed. This so-called Rehfuss gastro-duodenal tube can without inconvenience to the patient lie during the whole of the period of digestion in the stomach or intestine respectively. Now and then small specimens of the contents may be taken for closer examination. I have taken tests of from 5 to 10 ccms at intervals varying from 15 minutes to one hour. By means of the gauge marked on the rubber tube we can determine how far we have reached in the intestine if we succeed in getting it past the pylorus. In this way we can also take specimens of the contents of the stomach at various layers, up by cardia and down by fundus, in order to investigate whether there is the same composition at various layers.

By experiments on animals, it has been proved that in the lowest layer at fundus ventriculi there is found a larger quantity of gastric juice, and for that reason digestion proceeds more strongly there. In two or three cases I took various tests at the uppermost part from cardia and at the lowermost part from fundus, having beforehand by soundings and measurements convinced myself what the distance was from the teeth to cardia.

After a Bourget meal there at first appeared no free hydrochloric acid either up by the cardia or down by fundus: and the total acidity was the same for both tests (14 and 19 in the two tests respectively). After the lapse of one hour, two different tests were again taken. There was then found at fundus HCl. 13 and HCl. 39, and in the region about cardia HCl 14 and HCl 34 respectively, in the two tests. In the same way tests were made at various depths of the stomach in order to investigate whether there might be any difference in the concentration of alcohol at various layers. In one test with ale drunk with an Ewald meal there was found after 45 minutes a concentration of alcohol = 35 % for both tests. Sufficiently large tests (10 ccms) were taken to secure against error from mixing the tests in the stomach probe itself.

There can thus scarcely be any essential difference in the percentage of alcohol at the various layers in the stomach, at any rate at the commencement of the digestive process. On the other hand it is possible that during the meal, when the contents of the stomach after the lapse of some hours have become more digested, there may be found a difference in the concentration of acid nearest to the walls of the stomach, so that it is greater there than above and in the midst of the contents of the stomach. This is supported by the last of the above-mentioned tests, in which the total acidity was 68 and 72.

The peptic strength in these tests was not investigated for lack of gastric juice.

In all experiments there was ensured beforehand that the stomach was empty at the beginning of the experiment. If found necessary, washing out was performed. When in the experiments we speak of «gastric juice» we mean thereby the *contents of the stomach.*

In determining the quantity of the contents of the stomach, the latter was first emptied by means of an ordinary stomach pump, and was then washed out with a certain quantity of water. I then placed this aside in a measuring glass for twenty-four hours, and determined the volume in ccms. of the sediment. For the determination of the remainder I employed the Mathieu-Rémond formula.

With regard to the time taken for withdrawing the food, and the hour for taking up the gastric juice etc., care was always taken to secure that *Ewald's test breakfast* was eaten in exactly ten minutes, and removal was performed forty-five minutes after the meal was finished. For *Bourget-Faber's meal* 15 minutes was allowed for eating, and removal was performed three hours after.

The reason why a period of three hours was selected in the latter case is that I desired to have as wide limits as possible in my experiments in order that it might be easier to prove any possible difference between the two test meals to be compared. If we wait too long — more than three hours — we run the risk of all the contents of the stomach having left that organ, so that we have no means of finding out how far gastric digestion has proceeded, for normally a Bourget-Faber meal should have left the stomach after the lapse of three to five hours according to the Faber investigations. (Kemp) (88).

Determination of the free and combined hydrochloric acid, the total acidity and the hydrogen-ion-concentration.

According to *L. Michaelis* (108) the free hydrochloric acid is that which is present in the gastric juice in greater quantities than the quantity corresponding to the equivalent of pepton. The combined hydrochloric acid is that which is situated between the free hydrochloric acid and the isoelectric point.

For volumetric analysis of the free hydrochloric acid, there were formerly employed various methods such as that of Reoch, Köster, etc., until *Mintz* (115) proposed *Günzburg's* reagent. *Mörner* (183) employed *Kongo paper*, and *Töpfer* (162) *Dimethylamidoazobenzol.* Amongst other indicators proposed are: — ultra marine, malachite green, benzopurpurine, fuchsine, emerald green, tropäolin etc.

After Arrhenius' theory of dissociation, determination by means of titration and indicator was regarded as less reliable, the theory having shown that the proportions of acid do not remain constant in a liquid during titration. For by the addition of Na OH the equilibrium of the liquid is so disturbed that little by little the HCl will be free. Therefore titration always gives too high figures. Both *Michaelis* and S. P. L. Sørensen (156) have proved this further, and maintained that the titration method cannot be used for the investigation of HCl. We do not obtain the correct figures. Instead we must use the *hydrogen-ion-concentration method,* either the *electrometrical* or the *colorimetrical* method.

Comparative experiments for the determination of hydrogen-ion-concentration and titration have been carried out by various investigators. Thus Tangl (158) Foa (49) and Frankel (51) used the electrometrical method for the determination of the hydrogen-ion-concentration and compared it with the titration method in gastric juice.

Johanne Christansen (30 and 31) has undertaken comparative investigations in this matter. She considers that doubtless it is not possible to find the exact concentration of hydrogen-ion in the gastric juice by the titration method, but that nervertheless we can find the free HCl. in the contents of the stomach by an exellent method of titration which gives quite good results as regards the concentration of hydrogen-ion. For the free HCl is the most important source of hydrogen-ion in the contents of the stomach. She urges the following: — «Of course the determination of the hydrogen-ion-concentration and that of the free HCl are two quite different things. But we can compare the two methods of investigation in those cases where we have to deal with strongly acid gastric juices, the dissociation of the free hydrogen-ions being so considerable that they constitute the most essential factor of the entire hydrogen-ion-concentration.»

By comparing the figures obtained, Johanne Christiansen found that the gastric juice varies both when quite pure and when it is derived from an Ewald test breakfast or from a Bourget meal.

This is due to the albumen and peptones in the contents of the stomach by which the HCl is kept bound. This HCl is then dissociated by the addition of NaOH during titration.

According to Johanne Christiansen, Günzburg's reagent is an admirable indicator for the determination of the free HCl during titration. It is also serviceable for the determination of the hydrogen-ion-concentration, as the errors thereby arising are not so large.

When kept in the thermostat, it is found that the free and bound HCl alter after the lapse of hours and days. The Günzburg figures decrease, the Kongo figures remain unchanged, whilst the Phenolphtalein figures increase. This was shown by *Ambard* and *Foas* (4). It is due to the circumstance that the free HCl unites with the *amino groups* formed during digestion.

With regard to titration with Günzburg's reagent and dimethylamidoazobenzol in order to find the free HCl, Michaelis does not agree with Johanne Christiansen. The former considers that dimethylamidoazobenzol is better than the elaborate Günzburg titration and points out that the error he finds in titration with dimethylamidoazobenzol is due to the fact that the two points of reaction — the salmon pink and the lemon-yellow — are not noted. The salmon pink reaction point corresponds to a hydrogen-ion-concentration: $P_H = 2.5$ and the lemon yellow $P_H = 4.0$.

According to Michaelis we also find free HCl by titration with dimethylamidoazobenzol to salmon pink, as the gastric juice does not then contain any more free HCl. The bound HCl. lies between the salmon-pink dimethylamidoazobenzol titration and the isoelectric point, i. e. a $P_H = 6 — 7$.

According to Michaelis the reaction point of phenolphaltein lies at $P_H = 8.2$. Litmus paper has a reaction point at $P_H = 6.5$ (according to Johanne Christiansen $P_H = 7$). According to Michaelis the bound HCl. occurs as peptonhydrochloride arising at hydrolysis.

In these experiments *dimethylamidoazobenzol* was employed for the titration of gastric juice. In a manner similar to that of Michaelis there are also recorded the two points of reaction, the salmon pink and the lemon yellow, and in the experiments they are recorded in such a way that the figures which correspond to the salmon pink reaction are recorded as HCl, and the figure which corresponds to the lemon yellow is given in parenthesis, e. g. HCl. 18 (24). When only one figure is given it applies to the salmon pink reaction (free HCl.).

Simultaneously with the dimethylamidoazobenzol, of which only one drop of a 1 % alcoholic solution is employed, phenolphthalein is added and the point of reaction with phenolphtalein is read off on the first appearance of a red colour. Titration is performed with O.1 n NaOH.

For a determination of the actual hydrogen-ion-concentration in the gastric juice I have employed the colorimetric method according to *S. P. L. Sørensen* (156). There is employed, as suggested by Sorensen, the hydrogen-ion exponent P_H as expression for the of hydrogen-ion-concentration («the reciprocal» value of the Brigg logarithm applied to hydrogen-ions»), for we have the condition that hydrogen-ion-concentration with increasing P_H *decreases* and does not *increase*.

S. P. L. Sørensen has further worked out the colorimetric method. For this there are used various mixtures of salt, weak acids and bases, which *Henderson* terms «pushers». Of these pusher mixtures Fels (48) employed mixtures of vinegar and sodium acetate or ammonia and ammonium chloride respectively.

Friedenthal, *Salm* and others (52 and 53) used phosphate mixtures, L. Michaelis (110) used phosphate and acetate mixtures, as did also *Henderson*, *Brode* and *W. Lange*. *Sørensen* also used glycocoll, citrate and borate mixtures.

The difficulty of using the colorimetric method for the determination of the hydrogen-ion-concentration in gastric juice is that the protein matter enters into combination with various indicators and disturbs the investigation. In pepsin investigations, therefore, indicators of the azo group should be used. On the other hand congo red cannot be used. Indicators with the simplest composition are the best for the colorimetric method e. g. p. *nitrophenol* and also the *phtalein group*. By other experiments Sørensen proved that *alizarinsulphon* acid and *lacmoid* are useless as indicators when protein matter is present. Tropäolin etc., (p. benzolsulphon acid azodiphenylamin is bound by the acid albumen and cannot be used). According to *Sørensen* and *Palitsch* we should use the following indicators with biological liquids.

1.	Methyl violet	P_H	= 0.1 — 3.2
2.	Mauvein	«	= 0.1 — 2.9
3.	Methyl orange	«	= 3.1 — 4.4
4.	Methyl red	«	= 4.2 — 6.3
5.	Nitrophenol	«	= 5.0 — 7.0
6.	Neutral red	«	= 6.8 — 8.0
7.	Phenolphtalein	«	= 8.3 — 10.0

Between the two limits of P_H lie the limits which are of use as indicators. According to Sørensen dimethylamidoazobenzol lies between 2.9 and 4.0. In these experiments there was used *citrate mixtures* and for purposes of accuracy there were introduced more mixtures than those given by Sørensen.

The standard solution used appears as follows: —

1.					10	ccm.HCl.		P_H =	1.04
2.	1	ccm.	citrate	+	9	«	«	« =	1.17
3.	2	«	«	+	8	«	«	« =	1.42
4.	2.5	«	«	+	7.5	«	«	« =	1.66
5.	3	«	«	+	7	«	«	« =	1.92
6.	3.33	«	«	+	6.67	«	«	« =	2.27
7.	3.5	«	«	+	6.5	«	«	« =	2.5
8.	3.67	«	«	+	6.33	«	«	« =	2.75
9.	4	«	«	+	6	«	«	« =	2.97
10.	4.5	«	«	+	5.5	«	«	« =	3.36
11.	4.75	«	«	+	5.25	«	«	« =	3.53
12.	5	«	«	+	5	«	«	« =	3.69
13.	5.5	«	«	+	4.5	«	«	« =	3.95
14.	6	«	«	+	4	«	«	« =	4.16
15.	7	«	«	+	3	«	«	« =	4.45
16.	8	«	«	+	2	«	«	« =	4.65
17.	9	«	«	+	1	«	«	« =	4.83
18.	10	«	«					« =	4.96
19.	9.5	«	«	+	0.5	NaOH		« =	5.02
20.	9	«	«	+	1	«		« =	5.12
21.	8	«	«	+	2	«		« =	5.31
22.	7	«	«	+	3	«		« =	5.57
23.	6	«	«	+	4	«		« =	5.97
24.	5.5	«	«	+	4.5	«		« =	6.33
25.	5.25	«	«	+	4.75	«		« =	6.67
26.	5	«	«	+	5	«		« =	10.09
27.	4.5	«	«	+	5.5	«		« =	12.07

As indicator there was used from 1 to 9 methyl violet (0.1 gramme dissolved in 1 litre of water, i.e. 1 per 1000, of which 1 ccm. was used).

From 7 to 15 dimethylamidoazobenzol (one drop of a 1 °/oo alcoholic solution). From 14 to 19 *methyl red* (0.1 grammes dissolved in 300 ccms absolute alcohol plus 200 ccms water, of which 1 ccm. was used.) From 19 to 25 p. nitrophenol (0.4 grammes dissolved in 50 ccms absolute alcohol plus 940 ccms water. (E. Merck, Darmstadt, of which 2 ccm. was used.) From

25 to 27 *phenolphtalein* (0.5 grammes dissolved in 500 ccms alcohol plus 50 ccms water)

In the table given above: —

H.Cl = 0.1 n. hydrochloric acid.
NaOH = 0.1 n. caustic soda
Citrate = 0.1 mol. solution

of secondary sodium citrate. This is made by dissolving 21.008 grammes crystallized citric acid in 200 ccms carbonate free n. caustic soda thinned out with water to 1 litre.

Still better than the colorimetric method of determining the hydrogen-ion-concentration is that recommended by *L. Michaelis* (111) in 1917, electrometric titration designed for the determination of the hydrogen-ion-concentration in gastric juice. This Gaskette apparatus as it is called, however, is very complicated, and therefore, as mentioned previously, at the conclusion of his recommendation he advises the use of dimethylamidoazobenzol titration as a simpler and good method which even if not quite exact gives the approximate hydrogen-ion-concentration titrated in the manner which he further specifies.

Determination of the proteolytic capacity of the gastric juice.

For a number of years I have occupied myself with the determination of the proteolytic capacity of the gastric juice, and in the course of these researches I have felt the want of a simple and exact method. I have tried most of the commonest methods such as *Brücke's* method, *Mett's* method, *Grützner's* method, *Hammerschlag's* method, *Bettmann-Schröder's* method, *Gross'* method and *Kohlenberger's* pepsinometer. Of these Mett's and Hammerschlag's are the most commonly employed. Perhaps Mett's is used most of all. As is known, is consists in the use of thin glass tubes into which are sucked up the whites of hen's eggs, which are heated to coagulation. These tiny tubes are then placed in the gastric juice which is to be examined, and after remaining in the thermostat for a certain number of hours we read off (in some cases by the aid of a microscope) how much has been digested in the tubes. The defect of this method is that the gastric juice employed has no movement, so that is does not enter the narrow tubes. Sometimes we also find small bubbles of air in the tubes, and these interfere with the reading. Quite fresh white of egg is digested more quickly than that which is several days old, etc. Also the small distances to be read off easily give rise to errors.

In the case of some of these experiments, I employed Hammerschlag's method, although I was fully aware of its drawbacks. One of the greatest faults with his method is that to the solution of white of egg we add a constant of 4 ‰ of hydrochlorid acid, so that thereby the hydrogen-ion-concentration may be disturbed. The method is carried out in the following manner: —

> 10 ccms of a 1 % solution of white of egg, containing 4 ‰ of hydrochloride acid is added to 5 ccms of gastric juice and then placed for two hours in the thermostat at 30°. As check test we add 10 ccms solution of white of egg and 5 ccms water. After remaining for two hours in the thermostat the speciments are poured out, each into a separate Esbach-like tube and filled up to the mark with solution of picrin acid (Esbach's reagens). After twenty-four hours the precipitate in both tubes is measured. The proteolytic capacity is expressed in terms of the relation per cent between the difference in the quantities of white of egg in the two tubes.

For these experiments there were used tubes with finer divisions than those on the usual Esbach tube. Double determinations were always taken. We can obtain serviceable results in this manner after some practice. As a rule the discrepancy between the double experiments is less than 10 %.

Knowing how dependent pepsin digestion is upon the hydrogen-ion-concentration in the stomach, it will be evident that the above method does not lend itself to quite exact determinations.

According to *Michaelis* and *Sørensen* (110 page 70) the maximum activity of pepsin is situated at P_H = about 2.

In digestion of greater duration, pepsin acts best at $P_H = 1.5$. The longer the digestive process lasts the nearer the maximum activity of pepsin approaches a more acid solution. This is shown in curves by *E. Jürgensen* and *S. P. L. Sørensen* (83), who investigated the dissociation of acid albumen by pepsin in a solution of hydrochloric acid at 37°. According to Michaelis, the pepsin wanders both anodically and cathodically and in its maximum activity it wanders cathodically. At the maximum activity of pepsin, only the cathions are proteolytically active. No great alteration of the hydrogen-ion-concentration is needed before the proteolytic capacity of pepsin fails. At P_H = about 3 its effect is very small and at P_H = about 4 the peptic capacity of pepsin disappears.

In the digestive experiments of *Jürgensen* and *Sørensen* these investigators found, by determining the hydrogen-ion-concentration before and after digestion, that it had not appreciably altered during digestion. In later experiments they found that the maximum effect of pepsin in an experimental period of about one and a half hours, was at $P_H = 1.22$ and $P_H = 1.63$. Between these two figures lie the maximum effect. If digestion lasts longer — three to four hours — the maximum effect lies nearer to $P_H = 1.22$.

Johanne Christiansen (31) has shown by experiments that the solution of white of egg takes place best in the presence of a surplus of free HCl. However, with pepsin digestion we must differentiate between a solution of the coagulated white of egg and the further digestion of the dissolved genuine white of egg (*Abderhalden* (2)).

Thus the question now becomes whether digestion of the dissolved, genuine white of egg is carried out by an excess of free HCl.

In her experiments Johanne Christiansen, who employed *Sprigg's* method (152) in the form used by C. Schorr (146), found that pepsin digestion takes place best with 0.06 and 0.08 n. HCl. The amount of salt in the white of egg does not appear to have any influence. In order to dissolve coagulated white of egg there is needed free HCl, whilst the latter is not needed for digestion of the genuine albumen.

For the determination of the peptic capacity by Hammerschlag's method we make use of the effect of pepsin upon the dissolved albumen, just as Sørensen did by his formol titration method. However, the chief task of pepsin is to dissolve the coagulated albumen, and a method which is to determine the peptic capacity of pepsin should therefore first and foremost be based upon a measurement of the time which is taken to dissolve a certain quantity of coagulated white of egg. Such an indication will undoubtedly be the best and most exact method by which we can state the proteolytic capacity of gastric juice. We therefore subsequently abandoned all the above-mentioned methods and returned to that employed by Chittenden and Buchner, endeavours being made greatly to improve this method.

For these digestion experiments there was constructed a moveable drum to which were fastened a number of Erlenmeyer's bulbs. This drum, together with a small electric motor was placed in a Bang thermostat, and by the aid of the motor the drum was moved slowly round. In this way the contents of the Erlenmeyer's bulbs were kept in constant movement and this ensures that digestion in the thermostat takes place in a manner similar to that in the stomach.

The experiments were carried out in the following manner: —

A hen's egg was boiled for fifteen minutes, the shell removed, and with a thin sharp knife we cut off slices of the white of egg, about 5 mms. in thickness. In order to obtain *cubes of the white of egg* of equal size there was constructed a double knife consisting of two gilette blades at a distance of 4 mms. from each other. With this knife we first cut oblongs which are then cut across into cubes of equal size. To avoid error, these cubes of white of egg are weighed and have been found to weigh exactly 0.06 grammes. If when the weighing is checked they are found to weigh more than 0.061 and less than 0.059 they are rejected. To 20 ccms of contents of a stomach in small Erlenmeyer bulbs we add these cubes of white of egg and place them in the drum in the thermostat.

In comparative experiments I interrupted the digestive process after five hours, in which time a normal gastric juice had dissolved a cube of the above character. The contents of the bulb were poured on to a filter and kept there until the following day. The tiny filtered bulbs of white of egg that have not been entirely dissolved are then weighed and estimated according to *Kjeldahl*. As will be seen, this method is as exact as can be demanded, but it is also quite complicated.

The Kjeldahl determination in particular results in much loss of time. We therefore in some experiments only weighed the balls of white of egg after digestion, and compared this weight with a check cube placed in water. It was found that in this way just as exact figures were obtained as by the cumbrous Kjeldahl determination. However, this method of procedure was only used for the first comparative experiments on the addition of alcohol to the gastric juice.

In order to decide the peptic strength of the contents of the stomach, *with* and *without* alcohol, it was of course merely necessary to note the time when the cube of white of egg in the various bulbs was entirely digested.

To check the cubes of white of egg, the Kjeldahl determination was undertaken in order to investigate whether the quantity of water in each of the cubes was equally great. This was found to be the case, and the quantity of albumen was found to be = 12.4 %, the quantity of water 87.6 %. In order to find the albumen, we multiply the value found for N by 6.25, the albumen being considered to contain 16 % of nitrogen.

Determination of Alcohol.

For the determination of the percentage of alcohol in *spirits, wines* and *beer*, the *pycnometer method* was employed, as described according to J. König (page 759). There were employed pycnometers of both 50 ccms and 25 ccms, which were weighed after having been dried in the drying cupboard in the manner prescribed. The amount of spirits, wine or beer measured off, is then distilled in a specially arranged distillation apparatus with water jacket, cooled by means of running water.

The concentration of alcohol given in weight per cent and volume per cent is found from the specific weight by using *K. Windisch* and *Hehner's* Tables.

For the experiments there were used: —

Absolute Alcohol	weight %	94.10	Volume %	96.20
Cognac (J. Hennesey & Co.) .	« «	42.47	« «	50.10
Aquavit (Løiten 5 years old) and				

Poulsen's (10 years old) . .	weight %	36.0	Volume %	42.8
Claret (Chateau Meyney 1911)	« «	7.33	« «	9.74
Rhenish Wine (Rüdesheimer Rosenach 1900)	« «	8.49	« «	10.70
Pilsener Beer (Frydenlund Brewery)	« «	2.9	« «	3.65
Landsøl (Thin Lager) (Frydenlund Brewery)	« «	1.50	« «	1.88

With regard to the amounts of alcohol in the various bottles of beer, these vary somewhat according to the brewery from which the bottles come. Another factor is that which depends upon whether the amount of alcohol in the bottle is investigated immediately after the latter is uncorked, as the quantity of carbonic acid which at once escapes is then greatest and influences the specific weight of the beer.

For these experiments there was used beer from Frydenlund's brewery as this is one of the best and the most constant in its composition.

The amount of alcohol in three samples of Frydenlund's pilsener ale made in the spring months was found to be: — 2.77 (3.49), 2.88 (3.64) and 2.94 (3.71) weight and volume per cent respectively. For comparison we may refer to the following analysis of pilsener ale which was kindly sent me by B. Nissen, chief brewer at Frydenlund's brewery, (during the period October 1919 to June 1920): —

	Extract % Balling	Alcoholic weight %
No. 1.	4.33	2.91
« 2.	4.18	3.14
« 3.	3.91	3.23
« 4.	4.27	2.05
« 5.	4.57	3.91
« 6.	4.57	2.95
« 7.	4.36	2.97

We do not obtain so exact figures by the *pycnometer method* that the latter can be employed in the determination of the concentration of alcohol in the contents of the stomach and in the blood or the urine. For this is required a micro method which we did not possess earlier.

There were various more or less exact methods formerly made use of for the determination of alcohol in the secretions of tissues, urine etc.. *Bechamp* (7) *Subbatin* (155) *Lieben* (99) and *Heubach* (72) in their day used various methods which have been abandoned. *Bodländer* and *Strasmann* (22) used the potassium bichromate method, subsequently modified by *Benedict* and *Norris* (8) but *M. Nicloux* (121) was the first to devise an exact method. Various investigators have tried to modify Nicloux' method, e.g. *Bordas* and *Raczkowsky* (14) and *Cotte* (34).

The best modification however appears to have been made by *Erik Widmark* at Lund (176) and it is according to this method that we determined the degree of alcohol. The method is described in I. Bang's analysis of urine, to which reference is made (Page 82).

However exact may be the Nicloux-Widmark micro method of showing the minimum quantity of alcohol, yet it has certain inaccuracies which are at once noticed when the method is employed. These will be further discussed later on.

The *Nicloux-Widmark* method is carried out in the following manner: —

1. 0.1 solution of n. sodium thiosulphate (Merck) (24.83 grammes per litre), 50 grammes of n. sodium thiosulphate dissolved in 2 litres of water and allowed to stand for eight to fourteen days. 0.1 potassium bichromate produced by weighing 4.9083 grammes of pure p.b. dried at 130° C and dissolved in one litre of water and used for titration of thiosulphate. For titration we use 1 gr. pure J.K. and 5 ccms HCl (1:5) and then 20 ccms potassium bichromate whereby J. is separated.

II. 2.3 % solution of potassium bichromate, 2 ccms of which correspond to 9.35 of 0.1 n. thiosulphate.

In a reagent glass (receiver) we place 5 ccms concentrated H_2SO_4 and 2 ccms of solution of potassium bichromate (a quantity of chromate which is exactly reduced by 10 milligrammes of alcohol) and 5 ccms of the liquid are distilled in the distillation tube specially constructed by Widmark.

The distillation is thinned down to about 3 to 400 and we add 0.5 potassium iodide and two or three drops of boiled solution of starch.

It is found by this method that by check experiments we can find an error of as much as 10 %. This error is principally due to the circumstance that before titration we are liable to weaken the solution to various degrees so that the strength of the acid is less. For the accuracy of the method is highly dependent upon the regular use of a large and constant strength of acid. The addition of potassium iodide also plays a part, it being important in this instance also to use equal quantities. The solution of thiosulphate has been found to remain constant in the various lists which I have checked at intervals of some months, so that this scarcely causes any trouble. On the other hand it is important that the solution of potassium bichromate should be measured exactly. For this purpose we cannot use an ordinary burette as that is far too inexact. I used instead a 2 ccm. pipette with a thin neck above, whereby we can carefully measure off the required quantity with far greater exactitude.

The actual performance of the method must also take place in the same manner at each experiment. The same length of time must be used for distillation and titration. If the method is thus carried out, and we use a specified amount of water for titration, it will be found that the method is extremely exact, and the error in the check experiment does not exceed 0.05 milligrammes; indeed, by more exact readings we can reduce it to 0.02 milligrammes. That is to say, by this method we can show a percentage of alcohol of 0.00005 with a fair degree of accuracy. Such great exactitude is of course not required for these experiments, and therefore we have only taken into consideration three or four decimals.

W. Schweisheimer (147) in his experiments made the mistake of using two different strengths of acid, a weak one for the small figures below 0.5 per mil. He thereby obtains in that instance a too high degree of alcohol. Therefore, when for instance he states that he found 0.0495 per mil. alcohol in the blood after seven and a half hours in one of his experiments, whilst at the same time he gives the normal amount of alcohol in the blood as 0.03686 per mil, then in my opinion the error in this case can be so great, that he might just as well say that after the lapse of seven and a half hours there is no more than the normal amount of alcohol left in the blood. He also uses quite different limits in titration, whereby the latter is rendered still more difficult. The limits used by me, viz: from light blue to light green, are far sharper.

For mixing with water before titration we should not use more than 200 ccms. out of regard to the strength of the acid. This is done in such a way that the reagent glass (receiver) is used for measuring the amount of water, whilst at the same time we thereby get the receiver well rinsed out. By filling the latter six times we always succeed in having 200 ccms of liquid in the titration bulb for titration.

In the titration bulb we always use 10 ccms of liquid. If the strength of alcohol is greater than 10 milligrammes in these 10 ccms, we reduce it. We thus use from 1 to 10 ccms. mixed with water to 100 cms and of this take 10 cms for distillation.

In the check investigations of the gastric juice, to which alcohol was not added, it appeared that there were nearly always found quite small quantities of alcohol in the juice. The figure was not constant, but varied from 0.30 to 0.83 milligrammes, i. e. quite small but nevertheless demonstrable amounts.

It at once appeared that the greatest quantity was found after a Bourget meal, less after Ewald's, whilst in the gastric juice taken from an empty stomach the quantity of alcohol found was only 0.05 — 0.15 milligrammes in 10 ccms of gastric juice, i. e. about 0.00015 %.

For the sake of exactitude we therefore always carried out the determination of alcohol during the time of the check meal, and the above small percentage of alcohol was deducted.

The amount of alcohol in the test breakfast (Ewald) came from the *bread*, and it appeared that the various values depended upon how fresh the bread was. If just bought at the baker's the amount of alcohol was greater than if the bread had been lying for a day.

In Bourget's meal the tiny amount of alcohol came from the preserved cranberries (tyttebær).

I therefore took various *kinds of bread* and investigated the amount of alcohol contained in them. Such *determinations of alcohol in bread* have been made before by various investigators, but scarcely by such an exact method. As is known, whilst bread is being baked, there arises a quantity of alcohol through the influence of the yeast on the carbohydrates. There appear to be different opinions as to the size of this amount. *Almquist* and *Pettersen* (3) state that one kilo of flour produces during baking 2.5 grammes alcohol. *Ribbing* (138) draws attention to the difference between the amount of alcohol in warm new bread and in stale bread. He found 0.3 % alcohol in fresh «French» bread (wheaten bread). In Christiania *Schmelck* (145) carried out a number of experiments on the amount of alcohol in various kinds of bread. He found that new bread has an average quantity of alcohol = 0.52 %. The amount of alcohol diminished very slowly, so that in bread ten days old there was still about one half the amount of alcohol. In wort cake (malt) he even found 0.7 % of alcohol.

Pohl (130) gives the amount of alcohol in bread as only 0.0508 — 0.0744 %, and *Hefelmann* 170 gives only 0.036 for the same. *Bolas* (13) states that the amount of alcohol in English bread corresponds more closely to Schmelck's figures, namely about 0.4 % (average 0.2 to 0.4 %).

In experiments with various samples of bread I obtained the following figures: —

No. 1.	wheaten bread	(10 hours after baking). Alcohol	0.125 %
2.	» »	» » » »	0.096
3.	» »	» » » »	0.085
4.	rye bread	» » » »	0.160
5.	wort cake	» » » »	0.268
6.	» »	» » » »	0.252
7.	wheaten, stale, cut after 24 hours.	»	0.002

For the ordinary test breakfast there is used wheaten bread of the first three categories, that is to say, in an Ewald test breakfast where 40 grammes of wheaten bread are used and the contents of the stomach about 300 ccms, the percentage of alcohol should be about 0.017 %.

As will be seen, my figures for the amount of alcohol in bread are considerably below those found by Schmelck. It also appears that alcohol somewhat rapidly evaporates from bread. After ten hours only one half is left. The rate of disappearance is to a great extent dependent on the manner in which the bread is cut. If we cut it and let the pieces lie on the kitchen table all the alcohol disappears in the course of twenty four hours. The quantity of alcohol in bread not only depends upon how the dough has been treated (yeast), but upon how it is baked and kept after being baked.

In determining the amount of alcohol in *urine* the method of procedure was the same as in the case of the contents of stomach and intestine.

Ten ccms at a time were used, and test investigations of the urine passed before or during the experiment (acetonuri) were constantly made. In the various experiments carried out, in order to determine the amount of alcohol in the *blood*, 10 ccms of blood were taken from veins in the arm and distilled in a large distillation retort, with the addition of caolin powder in order to prevent accumulation of scum, and the distillate was then used for the estimation of the amount of alcohol by the micro-method.

Determination of tartaric acid and cream of tartar in claret and rhenish wine.

As previously stated, for these experiments we used claret (Chateau Meyney 1911) and rhenish wine (Rüdesheimer Rosenach 1900). In order to ascertain the amount of tartaric acid and cream of tartar in these wines, a determination was made of the total amount of tartaric acid, the free tartaric acid and the tartaric acid united with alkalies. The determination was made according to *J. König.* (Untersuchung landwirtsschaftlich und bewerblich wichtiger Stoffe 1906, page 773). We used 100 ccms of wine. In rhenish wine there was found in all 0.5125 tartaric acid and cream of tartar, and 0.129 free tartaric acid In claret 0.375 and 0.049 % respectively.

II. The Effects of Alcohol upon Resorption and Secretion in the Digestive Canal, with Special Reference to the Stomach.

As far back as the year 1856 *Claude Bernard* (9) made investigations on the effects of alcohol upon digestion. He experimented with dogs and found that digestion is suppressed by too much alcohol. In more recent times *Chittenden* (28) in particular made experiments with dogs in order to ascertain the resorptive conditions of alcohol. In his investigations he ligatured the pylorus and gave large doses of alcohol — quite toxic doses. He found that alcohol is quickly resorbed from the stomach. *Rosenfeld* (140) mentions investigations carried out by Dogiel who proved the presence of alcohol in the blood only one and a half minutes after being consumed, an instance of the rapidity with which alcohol is absorbed. *Pringsheim's* (123) investigations in Rosenfeld's laboratory at Breslau mainly concern alcoholic habitualness and toleration. The investigations were carried out with rats and gave no further clue to the resorption conditions of alcohol which *Nemser* (118) attempted by applying various stomach and intestine fistulas to dogs according to the fistula method of E. S. London. He attempted to find *where* in the digestive canal the various sections of alcohol are resorbed. Nemser's results do not agree with those of *Brandl* (118), who found that most alcohol is resorbed from the stomach. He carried out his experiments with dogs in the same manner as Chittenden. Similar experiments with dogs were carried out by Lönnquist (102) at Helsingfors and by *Volmering* (168) at the pharmacological institute at Giessen.

How readily alcohol is resorbed even through the mucuous membrane in the bladder is perceived by reading *Völtz* and *Baudrexel's* (170). Völtz, Baudrexel *and Dietrich's (169)* works on the resorption of alcohol from vesica urinaria and also the secretion of alcohol in the urine.

Gréhant (61) Friedmann (56) Nicloux (121) and *Schweisheimer* (147) have mainly concerned themselves with demostrating the presence of alcohol in the blood and determining the degree of alcohol there after the consumption of various doses of alcohol.

Toivo Seppä (149) like *Widmark* (176) mainly occupied himself with alcohol in the blood and the secretion of alcohol in the urine.

Mellanby (104) and *Edie* (40) also made experiments with dogs as to the conditions of resorption of alcohol, as did also *Billard* (11) and *Zitowitsch* (182).

As regards the effects of alcohol upon secretion, investigations were made by Metzger (105) by applying alcohol to nourishment enemas He found that by such an addition the amount of hydrochloric acid in the stomach increases, with which *Umber* (164) agrees, whilst *Michael* (107) disagrees.

The most fundamental investigations on the effects of alcohol on the conditions of secretion were carried out by *Pawlow* (126) at Petrograd, who terms alcohol a «psychic stomachicum». His opinion is that the slight narcotic effect of alcohol upon the central nervous system helps people to forget all the daily hardships and small worries which leave their mark upon the appetite.

Kast (85) (also experiments with dogs) says with regard to secretion, that 5 % solution of alcohol assists secretion, but in such a way that there is formed more hydrochloric acid but not pepsin. He regards alcoholic drinks below 10 % as not injurious to digestion, but on the other hand he says that alcohol of 20 % strength and upwards is directly injurious to the digestion, the effect however being dependent upon the fulness of the stomach. He considers spirits to be injurious as they bring about the chronic catarrh which is found amongst spirit drinkers. He recommends the consumption of wine with rich (fatty) diet, as it promotes secretion, increases the indirect secretion of the pancreatic juice, and facilitates the passage of food through the stomach into the intestines. Increased secretion was also found by *Blumenau* (12) and *Klemperer* (90) whilst Meyer (106) considers that alcohol has no effect upon the quantity of acid in the contents of the stomach.

All the above-mentioned investigators carried out their experiments with animals, which as will be understood are not as important as experiments with human beings.

As regards the latter class of investigations we have only *Kretschy's* (95). He carried out experiments with a woman suffering from fistula of the stomach. He found that alcohol had a detrimetal effect upon digestion, in that it occasioned a prolongation of the actual digestive processes. The woman in question contracted a fistula of the stomach after caries of a rib which by an abscess pentrated the stomach. He opened the gastric fistula a specified time after a meal (six hours) after the patient had consumed a certain quantity of alcohol (wine) with her meal. The objection has been raised to these experiments, that they were made upon a «sick woman» and «at night» so that they do not give a true representation of the effects of alcohol upon gastric digestion. Moreover, as is evident, the experiments were made with one person only.

Gluzinsky (60) carried out experiments with persons in such a way that he gave to the various individuals of his investigations increasing doses of alcohol and caused them to eat hard-boiled eggs. He finds from his experiments that digestion with alcohol takes place in two stages, the stronger doses of alcohol having at first an injurious effect upon peptic digestion. Later on however, there is another stage, when the quantity of acid in the stomach increases markedly, and the gastric juice obtains stronger digestive powers. At the second stage the digestion of white of egg proceeds considerably more quickly than during the second stage of the test experiment, so that the final result is that digestion proceeds about as quickly with alcohol as without it. He considers that small doses of alcohol have the effect of increasing the flow of free hydrochloric acid.

It will be seen from the above that a number of *experiments* have been made with *animals* in order to ascertain the *conditions* of *resorption* of alcohol, but on the other hand as regard the secretory effects of alcohol the experiments have been few and incomplete.

It is noteworthy that *more experiments have not been made with human beings.* Indeed there is no collected account of the effects of alcohol upon the conditions of secretion and resorption in human beings.

In a series of investigations, in addition to the condition of resorption on the addition of alcohol to various test meals, I endeavoured to ascertain the conditions of evacuation and the secretion of alcohol: with these are connected a number of experiments upon the conditions of alcohol in the intestine and also examinations of blood and urine. For the further elucidation of the question of secretion there are a number of investigations with healthy and sick persons who were given alcohol with their food.

By using alcohol in test meals with patients suffering from gastric troubles, I endeavoured to discover the indication and contra-indication of alcohol in these complaints, in order thereby to contribute towards the therapeutic uses of alcohol.

In these investigations everything possible was done to make them as similar as possible, and thereby the results as suited as possible for direct comparison.

But it must not be forgotten that the secretion of gastric juice is subjected to a number of influences the effects of which at any given moment it is difficult to control. It is therefore only on the basis of a very large series of investigations that it is possible to draw universal conclusions.

First Experiment.

Man. 46 years of age, healthy, weight 77 kilos. Has been an abstainer for 20 years. At an Ewald test breakfast given some days before there were found HCl.40. A.60. He ate on an empty stomach in fifteen minutes 100 grammes of boiled minced veal, and 50 grammes of wheaten bread with a little butter spread on it. He drank half a bottle of pilsener ale and 100 ccms of aquavit. The percentage of alcohol in the whole meal was 10.5 volume per cent, (8.35 weight per cent).

The total quantity of alcohol amounted to 53 ccms absolute alcohol, i.e. 0.7 ccms per kilo. of his weight. The bladder was emptied just before the meal.

Time after Meal	Test of contents of stomach	Reaction	HCl (bound)	A.	P_H	Alcohol in mgrms	Alcohol in Vol. %
Immediately after	14	acid	0 (4)	24	4.2	601	7.6 %
12 minutes	15	«	0 (4)	28	4.0	463	5.5 %
30 minutes	10	«	4 (8)	32	—	340	4.3 %
1 hour	12	«	8 (13)	31		221	2.8 %
$1^1/_2$ hours	4	«	13 (17)	33		200	2.5 %
2 hours	17	«	24 (32)	70		133	1.6 %
$2^1/_2$ hours	65 remainder	«	29 (42)	71	1.6	23	0.3 %

Urine.

Time after Meal	Quantity in ccms	Alcohol in mgrms	Secreted in grms
12 Minutes	8	1.1	0.0009
30 «	12	3.6	0.0043
1 hour	35	4.0	0.0140
$1^1/_2$ hours	24	5.4	0.1305
2 «	82	5.1	0.0418
$2^1/_2$ «	12	5.0	0.0060
	390		0.1975

A blood test taken one hour and 5 minutes after the conclusion of the meal showed 0.065 weight % = about 0.08 volume % in the blood. At the same time the strength of alcohol in the urine was 0.054 % = about 0.07 volume %.

There was secreted in the urine a total of (390 ccms) 0.1975 grammes alcohol = about 0.25 absolute alcohol. Of the 53 ccms which he received per os only 0.47 % was secreted through the kidneys.

An hour and more after the meal the blood contained 0.08 %. If we estimate the quantity of blood for a 77 kilo man as 6 litres, the quantity of alcohol will be 4.8 ccms. That is to say, that at the time in question about 10 % of the quantity of alcohol he has received is circulating in the blood.

From the quantity of alcohol which he received during the meal, and from the degree of the alcohol found in the contents of the stomach immediately after the meal, we can estimate the amount of gastric juice he has secreted during the fifteen minutes he occupied in eating. It is true that the beer was given during the meal, so that he drank a glass after 5 and 10 minutes, and it is conceivable that a small quantity may thus have been absorbed before the test was made; but in any case this is so inconsiderable that it cannot essentially influence the result estimated. For of course the most important quantity of alcohol was taken immediately beforehand in the form of aquavit.

As the concentration of alcohol during the meal was 10.5 % and the first test of the contents of the stomach showed 7.6 %, it appears that in the course of fifteen minutes in the stomach there must have been secreted about 190 ccms of «gastric juice,» with which the food has mixed. The calculation is naturally uncertain on account of the saliva swallowed, evacuation through pylorus etc., but nevertheless it gives us a slight idea of the approximate amount of gastric juice, mixed with saliva etc., that is produced.

We did not succeed in reaching down to the intestine with the Rehfuss tube. This is also shown by the fact that the reaction in all tests taken out was acid.

In the various tests taken at intervals of fifteen minutes to half an hour, it is quite interesting to see how at first free HCl is completely lacking in the contents of the stomach, and that there are only quite small quantities of bound HCl present. For the same reason the concentration of hydrogen-ions is so low that at first practically no digestion can take place. It is not until there is a hydrogen-ions concentration of $P_H =$ about 2.5 — 3 that digestion begins to be accelerated. It is greater at a P_H which is less than 2.

After two and half hours the remainder of the contents of the stomach was taken out and this appeared to be 65 ccms. The contents of the stomach, which at first consisted of 700 ccms have thus by resorption and evacuation through pylorus been reduced to 1/10 in the course of two and a half hours.

From the quantity of urine secreted, which was measured at the time when the various samples of gastric juice were taken, it will be seen that the quantity of urine is greatest during the period from 1 to $1^1/_2$ hours after the end of a meal. In that half hour there are secreted 241 ccms, i.e about 62 % of the total amount of urine. The secretion of urine remains rather high for another half hour, amounting during the next half hour to 82 ccms i.e. about 21 %, decreasing considerably to about 3 % during the succeeding half hour. The secretion of urine has thus in the case before us mainly (about 83 %) taken place during the time from 1 to 2 hours after the meal.

In the same period the secretion of gastric juice also appears to be most active for the case in question. If we compare the figures for acidity in the various tests, it will be seen, that the true secretion of gastric juice does not commence until half an hour after the meal, i.e. somewhat earlier than the secretion of urine, and it is most intense in the period between 1 and 2 hours after the meal.

If however we compare the concentration of alcohol in the various speciments of gastric contents, it is seen that the decreasing concentration of alcohol does not coincide with the figures for acid, which may indicate that the *absorption of alcohol from the stomach begins immediately after it is consumed.* After the lapse of one hour, over 70 % must already have been resorbed. This also agrees with the quantity of alcohol secreted in the urine. The largest *secretion of alcohol through the kidneys* takes place during the first stage of digestion. About 90 % of the total amount of alcohol in the urine is secreted during the time from 1 to 2 hours after the meal.

Second experiment.

In order to check and compare the results of the first experiment, the following experiment was made with the same man two days later: —

He ate in about sixteen minutes 100 grammes veal, 50 grammes wheaten bread with butter, i.e. exactly the same as in the previous experiment, but *without alcohol*, so that instead of receiving half a bottle of beer he had 360 ccms of water and instead of 100 ccms of aquavit he had 100 ccms of water to drink afterwards. In this experiment, too, the stomach and bladder were empty before the test was commenced.

Time after Meal	Test of contents of stomach	Reaction	HCl	A.	PH	Alcohol mgrms.
Immediately after	22	acid	0 (2)	3	4.2	0.55
12 minutes	9.5	«	0 (4)	6	—	—
30 minutes	6	«	3 (10)	26	—	—
1 hour	12	«	9 (14)	28	—	—
1½ hours	5	«	10 (16)	40	—	—
2 hours	10	«	14 (22)	40	—	—
2½ hours	90 (remainder)	«	20 (29)	49	1.8	0.25

Urine.

Time after Meal	Quantity in ccms	Alcohol mgrms.
12 minutes	22	0.15
30 «	14	0.07
1 hour	55	0.05
1½ hours	105	0.08
2 hours	18	0.05
2½ hours	16	0.05
	230	

The blood test was taken one hour and five minutes after the meal and showed (in 10 ccms, 0.20 mgrms) a percentage of alcohol of 0.002, which must no doubt be regarded as the normal quantity of alcohol in the blood. The urine at the same time contained 0.0008 %. In the other urine tests only up to 0.0015 % was shown. These small quantities of alcohol merely express the normal quantity of alcohol in the urine and are within the limits of error of the method. Likewise in the contents of the stomach there was found at first 0.0055 and finally 0.0025 % of alcohol, also quite normal values.

As will be seen, these values only show one half of the quantity of alcohol found by Schweisheimer. This depends upon the analytical methods. Schweisheimer obtained too high figures throughout and over-estimated the accuracy of his method. Cp. what was previously stated regarding Schweisheimer's method when discussing methods.

If we compare the amounts of acid and hydrogen-ions concentration of found in the experiment with those found in previous researches, it will be see that at first they are somewhat alike. There is the same lack of HCl and the quantity of bound acid is almost the same, whilst it is true, the total acidity is somewhat greater in the alcohol experiment. After the lapse of one and a half hours, however, the difference is greater, the free HCl, the bound HCl the total acidity and the hydrogen-ions concentration of all being higher in the experiments after the meal with alcohol. The final result after $2^1/_2$ hours is that in the »alcohol« meal there is present about 50 % more free HCl than in the case of the check meal.

By comparing the peptic capacity of the contents of the stomach in these two cases, the difference also becomes more striking whilst the gastric juice from experiment I (the alcohol experiment) digested the cubes of white of egg in the thermostat in five hours and fifteen minutes, a similar cube in the same quantity of gastric juice (20 ccms from experiment 2) was not entirely digested until the lapse of seven and a half hours.

The circumstance that the contents of the stomach after $2^1/_2$ hours in this experiment were 65 ccms whilst in experiment 2 they were 90 ccms, is undoubtedly connected with the more rapid digestion in experiment I.

It is also noteworthy that the total *secretion* of *urine* in the two experiments was so different. The secretion of urine in the »alcohol« meal was found to be 390 ccms i.e. almost double that in the check meal (230 ccms). We see here, too, that the secretion of urine is greatest during the period from 1 to $1^1/_2$ hours after the meal.

Experiment 3.

A man, 30 years of age, healthy, weight 65 kilos. In 10 minutes he ate 100 grammes of veal, 50 grammes of wheaten bread with butter, and was given with it half a bottle of pilsener beer (350 ccms). He thus ate the same as in experiments 1 and 2, but was not given aquavit or other alcohol except that in the half bottle of beer, i.e. 9.7 ccms of alcohol, corresponding to 0.15 ccms per kilo of weight of body.

Time after meal	Test of contents of stomach	Reaction	HCl	A.	PH	Alcohol in mgrms	Alcohol in volume %
15 min.	6	acid				100	1.4
30 «	6	«				82	1.0
45 «	5	«				24	0.35
1 hour 15 «	5	«				test destroyed	
1 « 30 «	4	«				22	0.3
2 hours	7	«				22	0.3
2 « 15 «	4	«				19	0.25
2 « 45 «	7	«	4 (6)	24	2.6	8	0.1
3 « 15 «	6	slightly acid				0.15	
3 « 30 «	5	alkaline				0.15	
3 « 45 «	6	acid				0.15	
4 hours	85 (remainder)	«	9 (11.5)	40	2.3	0.15	

Urine.

Time after meal	Quantity in ccms	Alcoholic mgrms	Secreted in grammes
15 min.	10	0.98	0.00098
30 «	9.5	0.32	0.00031
45 «	14	0.32	0.00045
1 hour 15 «	19	0.70	0.00133
1 « 30 «	50	0.82	0.00410
2 « 15 «	31	0.11	0.00034
2 « 45 «	88	0.05	0.00041
			0.00794
3 « 15 «	95	0.05*)	
3 « 30 «	77	0.05	
3 « 45 «	89.5	0.05	
4 «	85	0.05	
9 «	160	0.05	

*)In stating the amount of alcohol after three hours, the values found were regarded as so small that they were reckoned = 0, and the average figures were recorded. It is for that reason that the figures are so alike.

After three hours fifteen minutes there appeared slight acidity with the reaction in the specimen obtained as a sign that the tiny »olive« on the Rehfuss tube had passed the pylorus and was in the duodenum. In the next test after three hours 30 minutes, there were distinct alkaline contents which came up with a faint yellowish appearance. The succeeding tests after 3 hours 45 minutes were still alkaline and the contents of the stomach also showed a greenish colour.

After four hours the tube was withdrawn and the rest of the contents of the stomach was brought up by passage through the stomach, in all 85 ccms. This showed HCl.9 (11.5) A.40 and $P_H = 2.3$. There was a good deal of slime in the contents thus obtained.

It thus appears that this comparatively young man had a worse gastric digestion than we should have expected. It is true the stomach partly empties itself after the lapse of three to four hours, but there is quite a considerable remainder in the stomach after four hours. This must presumably be attributed to chronic gastritis with reduced gastric secretion.

A fresh test, taken for the sake of checking the results after the lapse of two or three days, also showed according to Ewald's HC1.5 (7) Sanguis — ; Slime +.

It is noticeable in this experiment how quickly the alcohol disappears from the stomach. After half an hour about 60 % of the alcohol has been resorbed in spite of the existing gastritis, and after 45 minutes about 85 % have disappeared from the stomach. The amounts of alcohol which we find in the contents of the stomach and intestine respectively after three hours is so small that they are only to be regarded as normal amounts and as in the case of the urine can be placed at 0.

With this dose of alcohol (half a bottle of beer) the amount of alcohol secreted in the urine is extremely small, amounting to only 0.00794 grammes i.e. about 0.1 % of the amount of alcohol consumed.

The degree of alcohol found in the contents of the intestine, amounting to 0.0015 % is not greater — rather less — than the amount of alcohol found in the blood.

Experiment 4.

Man, 28 years old, at the time in question no digestive trouble, weight 55 kilos. Was given the same food as in the preceding experiment, and besides half a bottle of pilsener beer and 20 ccms of brandy (cognac) i.e. 0.36 ccms per kilo of bodily weight. The amount of alcohol in the entire meal was 4.55 volume per cent.

Time after meal	Test of contents of stomach	Reaction	HCl	A.	Alcohol in mgrms.	Alcohol in volume %
2 hours	35	acid	18 (22)	72	26.85	0.27
3 «	10	«				
3 « 5 minutes	50 (remainder)	« greenish colour	10 (15)	50	5.3	0.07

Urine.

Time after meal	Quantity in ccms	Alcohol in mgmrs	Secreted in grms
2 hours	55	5.0	0.0275
3 « 5 mins.	65	1.48	0.00962
	120		0.03712

We did not succeed in getting the Rehfuss tube into the intestine in spite of a number of attempts by placing the patient on his right side in various positions. The fact that the contents of the stomach after three hours exhibit a lower degree of acidity than after two hours is doubtless due to vomiting which the patient had on account of various manipulations. Thereby a quantity of the contents of the intestine entered the stomach, where the contents were finally quite gall coloured. Of the 19.7 ccms of alcohol which the patient consumed, 0.037 grammes, i.e. about 0.2 % were secreted through the kidneys in the course of three hours.

The percentage of alcohol which was originally 4.55 % was reduced after two hours to 0.27 % in the contents of the stomach, and after three hours practically all had disappeared, there being left only 0.07 %.

The patient stated of his own accord that he could feel he had consumed alcohol only seven minutes after he had taken it.

Experiment 5.

A number of experiments were made with various persons in order to get the Rehfuss tube past the pylorus and into the intestine, but this could not be done until towards the end of a meal. The object was to ascertain whether the alcohol — as had been noticed — which disappeared so quickly from the stomach, had merely emptied itself into the intestine, or whether it really was resorbed so quickly through the mucuous membrane of the stomach, for if after the lapse of several hours we succeeded in getting the tiny »olive« past the pylorus, this would be at so comparatively late a stage that the alcohol would long since have disappeared both from stomach and intestine. After the lapse of a few hours alcohol is not found there to a greater degree than elsewhere in the organism and in the urine.

In order to achieve this object, i.e. to get down to the intestine quickly, we made use in this experiment of a *gastro-enterostomatized* man, with whom it was easier to take specimens immediately after a meal.

A.O. mason and handy man, was in the habit of taking a dram with his food now and then in order to »digest it better«, otherwise he consumed scarcely any alcohol. Five years before he was treated at the medical section of Ullevaal Hospital for ulcus ventriculi after hematemese, and was subsequently removed to the surgical section where shortly afterwards he was operated upon. According to information supplied from that section (Senior Physician Schilling) there were found at the operation extensive fixed adhesions between the edge of the liver, gall bladder, omentum and duodenum. No wound could be detected (in spite of previous hematemesis) nor any concrements in the gall channels. Gastro-enterostomi was performed (adidity 70—95 ccms). He was re-examined about two years later and exhibited alternating symptoms of dyspepsia with moderately severe pains in the epigastrium, these being independent of meals. He has subsequently been able to work and the dyspeptic troubles have mostly disappeared.

The Røntgen photograph taken of him later on, shows a practically normal evacuation of the stomach, possibly slightly rapid. The figures for acidity according to Ewald now show HCl 10(16) A.35. Five years previously they were HCi 32 A.51.

In 10 minutes he ate the same food as at the previous test and was given to drink half a bottle of landsøl (thin lager) (350 ccms) and 50 ccms of aquavit (Løiten 5 years old). As he weighed 70 kilos and received during the meal 27.5 ccms of pure alcohol, the latter makes about 0.4 ccm. per kilo of bodily The alcoholic percentage of the meal was 6.4. The urine passed before the meal showed an alcoholic percentage of 0.002.

Time after meal	Test of gastric-intest. juice	Reaction	HCl	A.	PH	Alcohol in mgrs	Alcohol in vol. %
5 min.	6	acid, light clear				280	3.54
15 «	6	amphote, gall colour.	0 (0)	0	6.6	22	0.27
30 «	22	acid.	8 (13)	29	2.66	87	0.85
45 «	10	«	8 (12.5)	34	2.35[1]	47.3	0.60
1 hour	28	«	13 (22)	46	2.27	34.6	0.41
1 hour 30 «	21	light acid	0 (0)	8	4.84	14.3	0.16
2 hours	20	amphote	—	—	6.6	3.3	0.05
2 « 5 «	16	alkaline, light	0 (0)	6	6.9	0.54	
3 «	44 (remainder)	alkaline intestinal juice	0 (0)	6	7.6	0.08	

(The stomach was empty) all intest. juice possible was secured.

[1] uncertain.

[2] practically amphote reaction.

Urine.

Time after meal	Quantity in ccms	Alcohol in mgrs.	Alcohol secreted in grms.
15 minutes	9	0.1	0.0001
30 «	5	20.0	0.0100
45 «	5	7.5	0.0038
1 hour	5	1.7	0.0009
1 « 30 mins.	8.5	1.7	0.0014
2 hours	14	1.6	0.0022
3 «	30	1.5	0.0045
	76.5		0.0229

Even fifteen minutes after the meal we succeeded in getting the tube below the gastro-enterostomi opening and down in the intestine.

The contents of the intestine secured had a comparatively low degree of alcohol, only 0.27 % whilst that in the contents of the stomach 10 minutes before was 3.54 % and fifteen minutes later 0.85 %. That is to say, in this patient a comparatively small quantity of alcohol passed on into the intestine, for even though it distributes itself quickly, it is still remarkable that the degree remains so much higher in the stomach. It would appear as if the main part of the alcohol introduced into the stomach in the usual strengths consumed are resorbed through the wall of the stomach and thence carried direct into the blood channels. A smaller quantity passes out into the intestine and is resorbed there. In this man with gastroenterostomi we should of course expect to find more rapid evacuation than normally if the alcohol usually passed into the intestine just after entering the stomach.

We also receive from this experiment a definite impression as to the rate at which alcohol is resorbed. During the meal the percentage of alcohol which was originally 6.4 % in the course of the 5 minutes which elapsed before the first test was taken, was reduced to 3.54 % in the contents of the stomach. The greater part of this reduction was of course due to the mixing of the alcohol with gastric juice. If we reckon that no alcohol was as yet resorbed, this means that during the meal (in fifteen minutes) there are secreted 200 ccms of gastric juice, saliva etc. We must however, assume that a small quantity of alcohol has already been resorbed, so that we cannot well place the secretion of saliva and gastric juice during the meal at less than about 170—180 ccms. This also agrees closely with experiment I, in which the secretion of gastric juice during the meal was found to be 190 ccms. We would point out that there are errors connected with this method of calculation, which is only to be regarded as approximate (Cp. under Experiment I). After the lapse of half an hour the percentage of alcohol in the contents of the stomach is only 0.85. That is to say, about 75 % of the alcohol has been resorbed in the course of about half an hour, and in the course of one and a half hours there is practically no alcohol left in the stomach. At this stage there is also only a small quantity of alcohol in the intestine, the degree then being 0.16 % after one and a half hours, and after two hours nil, for we consider the amount of alcohol found, 0.05 % (Cp. Test I) to be the normal quantity of alcohol in the intestine.

From this experiment it will also be seen how quickly the alcohol is resorbed. It scarcely reaches the intestine at all, because it is resorbed so quickly through the gastric mucuous membrane. As soon as the alcohol enters the stomach resorption begins, and if the quantity of alcohol is not too large — does not exceed 0.5 ccms per kilo of the bodily weight — it is practically resorbed in its entirety in the course of about one hour after the meal. By far the greater part about 75 % — is resorbed as early as during the first half hour.

As will appear from the experiment, we succeeded in taking the first test of the contents of the intestine (test 2) after the lapse of only 15 minutes. The distance to the teeth was measured before the tiny «olive» was withdrawn. During the latter process a slight resistance was observed when the gastro-enterostomi opening was passed. The latter appears to be situated 56—58 cms. from the teeth, and olive was about 10 cms. below the opening. The Rehfuss tube then remained in the stomach after having been drawn up through the gastro-enterostomi opening, and the next tests were taken from the stomach (3. 4 and 5).

In these tests there were also determined the free and bound H. Cl., the total acidity and the degree of hydrogen consumed. The circumstance that the figures found are so low, especially that for free HCl, is due to a quantity of bile being regurgitated up into the stomach through the gastro-enterostomi opening, thus binding a quantity of hydrochloric acid (gall coloured contents of stomach).

In the 6th, 7th, 8th and 9th tests the tube was again down in the intestine, from which was drawn up alkaline, slightly green contents of the intestine. In these tests no hydrochloric acid could be demonstrated and the degree of hydrogen-ions changed considerably and passes the neutral margin. 10 ccms. of test 9 were titrated with litmus as indicator, and showed an alkalinity of 7.5 there being used 0.75 c.cms., O. l. n. HCl, before the liquid again became acid (red). After titration with phenolphtalein as indicator, it showed as stated 6. P_H should according to that lie between the extremes for litmus (which is 6.5 according to Michaelis, 7.0 according to Christiansen) and the extreme for phenolphtalein, which is situated at P_H = 8.2 By the colorimetric method there was found a P_H = 7.6.

In the last test there was included as much of the contents of the intestine as could be got up, slow suction being made all the time that the tube was being withdrawn. We thereby obtained 44 c.cms. of contents of intestine. The stomach then appeared (after 3 hours) to be completely empty.

In test No. 7 the tiny olive in the Rehfuss tube proved to be 106 cms. from the teeth, and in test No. 8 the distance was 118 cms. This test of the contents of the stomach can thus have been taken 60 cms. below the gastro-enterostomi opening. Since, according to Senior Physician Schilling's report, the latter lies about 90 cms. from pylorus, the tube may have been 1 $^1/_2$ m. down in jejunum (reckoning from pylorus). Thus after 2 hours there is only a minimum amount of alcohol, viz. 0.0054 % in the contents of the intestine, thus far down in the latter. At the same time there was 0.0015 % in the urine.

As mentioned above, it was found that the alcohol in this experiment descends into the intestine in small quantities only. Even just after consuming $^1/_2$ bottle of landsøl and 50 c.cms. of aquavit (about 3 drams), which gives a degree of alcohol in the stomach = 3.54 %, we find only small quantities of alcohol in the intestine (0.27 %).

The total secretion of alcohol in the urine in this experiment amounted to 0.0229 grm., i. e. about 0.1 % of the quantity of alcohol consumed is secreted through the kidneys. The diuresis is comparatively small, only 76.5 c.cms. in 3 hours. This is due to the circumstance that the patient perspired a great deal during the experiment, which was performed on a hot summer day.

Even though we cannot draw any general conclusions from these few experiments as to the degree of alcohol in the intestine, it would nevertheless appear that the degree of alcohol is considerably lower than in the stomach, and that alcohol descends to the intestine in small quantities only, it being resorbed so quickly through the walls of the stomach.

With the somewhat small doses of alcohol used here, it appears that so small quantities of alcohol reach the intestine — in the present case to a degree of only 0.27 % — that the alcohol in the intestine can scarcely have any directly injurious effects upon intestinal digestion.

According to Chittenden and others, a degree of alcohol of 10 % is necessary for any disturbing effects upon the digestive capacity of the intestinal juice, and such a high degree of alcohol will not be found in the intestine, even with rather large doses of alcohol. We shall scarcely see any *directly* injurious effect upon the intestinal juice or mucous membrane, even in the case of concentrated doses of alcohol. It is thus primarily the mucous membrane of the stomach and the gastric juice which are affected by use of concentrated doses of alcohol.

III. The Inlluence of Alcohol upon the Proteolytic Effects of the Natural Contents of the Stomach

Of a number of investigations to be found in medical literature regarding the effects of alcohol upon artificial digestion in vitro, I will first mention those of *W. Buchner* (19). He carried out a series of investigations at Leube's clinic in Erlangen on the effects of alcohol upon digestion. By adding alcohol to various preparations of pepsin he found that pepsin digestion completely ceases with a concentration of alcohol = 20 %. With a concentration of alcohol of 10 % in the digestive liquid the proteolysis begins to be inferior.

In America, at the physiological laboratory of Yale University, there have also been carried out a number of thorough experiments upon the effect of alcohol on preparations of pepsin and trypsin. These were carried out by *Chittenden* and *Mendel* (27).

In these experiments there was used the preparation of pepsin called «Scale». The experiments were conducted as follows. The globulin is separated from the white of egg by means of HCl. After neutralizing the whole mass is dried. In a container of about 200 c.cms. capacity, 0.4 % HCl and pepsin are added to the white of egg (10 to 20 c.cms.) to 100 c.cms. We shall here report two of the experiments. The result of the proteolysis at various concentrations of alcohol is given in % of the amount of white of egg which is dissolved without the addition of alcohol.

Experiment 1.

With	0	%	alcohol	— 100	relative	pepsin	digestion	(6 hrs.)
»	6	»	»	94	»	»	»	»
»	12	»	»	76	»	»	»	»
»	18	«	»	66.6	»	»	»	»

Experiment 5.

With	0	%	alcohol	— 100	relative	pepsin	digestion	(2 1/2 hrs.)
»	1	»	»	100.7	»	»	»	»
»	3	»	»	96.8	»	»	»	»
»	5	»	»	95.3	»	»	»	»

On the addition of 1 to 2 % of alcohol we find a slight increase in peptic power, whilst on larger additions (5 %) there is a slight decrease in the peptic power. The authors embody their results in the following statement: — «First it is plainly manifest that in the presence of small amounts of alcohol (1—2 %) gastric digestion may proceed as well or even better than under normal circumstances. In fact, many of our experiments show a slight increase in digestional power, when the mixture contains 1 or 2 per cent. of absolute alcohol.» Further. «At the 5—10 % limit, however, there is a marked decrease of peptic digestion and at the 15—18 % limit the peptic value is reduced by 1/4—1/3.»

The investigations mainly deal with various kinds of alcohol. Regarding whisky the authors say in conclusion, «We may thus conclude, with Roberts, that taking into account the quantity of whisky commonly used dietically with meals, the amount so consumed is not sufficient to appreciably retard the speed of gastric digestion.»

Cognac (brandy) in small doses, 1—2 %, has also no injurious effects, but the reverse is the case when we reach over 5 %.

Rum likewise.

Chittenden and Mendel are fully aware of the defects of investigations which they carried out, these investigations comprising only the purely chemical processes in digestion, proteolysis and amylolysis, without regard to the other work of digestion, in secretion peristalcis and resorption. In fact they say in conclusion, «Finally it is to be plainly understood that these conclusions apply solely to the influence of the various liquors studied upon the purely chemical processes of digestion i. e. upon amylosis and proteolysis. The results recorded do not afford data for drawing any broad or general conclusions regarding the influence of alcoholic drinks upon digestion and alimentation since they throw no light upon possible mortifications of secretion or peristalcis — but before we can answer the question, How do alcoholic fluids affect digestion ? we must ascertain the influence of these fluids upon the secretion of digestive juices and upon the absorbtion of the products of digestion, as well as upon peristalcis, and not until these points have been thoroughly studied shall we be able to understand fully the actions of these beverages upon the whole process of digestion».

Amongst other authors who have carried out investigations upon the influence of alcohol upon pepsin proteolysis in vitro I may mention *Bikfalvis* (10) who finds that small quantities of alcohol have no effect upon proteolysis in vitro, whilst larger quantities disturb it. *Kast* (85) in his experiments arrived at practically the same result as Buchner, viz. that a 10 % concentration is the limit for a noticeable derogatory effect upon digestion. *Werther* (175) carried out a number of experiments, in which inter alia he investigated the various pepsin wines (Blell, Burth, Meisel and Schernig) and found these only interfere with pepsin digestion.

Wegele (173) is of the opinion that alcohol hinders digestion. He refers to *Werther* and *Hugonneug* (175 and 81). *Mugdan* (117) merely criticizes the results arrived at by Buchner.

I also have carried out a number of experiments with artificially produced preparations of pepsin and pancreas, to which increasing doses of alcohol were added, in the same manner as Chittenden and Menden and also Buchner.

Amongst the preparations of pepsin used in these experiments were *Scale* pepsin, *Langebek* pepsin, *With* pepsin and the officinal preparation. I have also used *pepsin wine* (vinum pepsini off.) which shows inferior digestive powers to a 2 % solution of pepsin alone. Pepsin wine has only one half peptic strength. This is due to the circumstance that vinum pepsini contains too much alcohol (sherry) viz. 13.6 %. In so strong concentration of alcohol the effects of pepsin are injured.

I have conducted a number of investigations by adding alcohol to the contents of the stomach. These were so carried out that to a definite quantity of the contents of the stomach from various persons there were added increasing quantities of alcohol. The experiments were carried out in accordance with the method described on page 9. Of these experiments only a few will be described here for the further illumination of the effects of the concentration of alcohol.

Experiment 6.

Experiment with the contents of the stomach of a man, 43 years, of age, healthy, 210 c.cms. secured. After Ewald's test breakfast the contents of the stomach showed HCl 20 (24), A.39. $P_H = 1.9$ After Bourget's meal the stomach showed normal evacuation conditions.

M = gastric contents in c.cms.

Egg = cubes of white of egg, the contents of white of egg given in mgrms.

Alc. = Alcohol 96.20 % in ccms.

K = Kjeldahl determination of remainder of white of egg in mgrms.

M		Egg	Ccms. Water.	Alc.	Alc. in %	Weight in grs.	K.
1.	20	7.43	5	0	0	0	0
2.	»	»	4	1	3.85	0	0
3.	»	»	3	2	7.70	0	0
4.	»	»	2	3	11.55	0.015	1.873
5.	»	»	1	4	15.40	0.054	8.320
6.	»	»	0	5	19.25	0.063	9.635

5 hours period of digestion in the thermostat with moveable disc, at 38° C.

The circumstance that the figures for the determination of white of egg according to Kjeldahl are larger here than in the original cube is due to it being imbibed with gastric juice and in consequence containing more albumen.

Experiment 7.

Contents of stomach of woman 25 years of age, healthy. HCl. 10. A.31. $P_H = 2.27$.

	M.	Egg	C.cms. Water	Alc.	Alc. in %	Weight in grs.	K.
1.	10	0.065	20	0	0	0.024	
2.	»	»	19	1	3.2	0.019	
3.	»	»	18	2	6.4	0.010	
4.	»	»	17	3	$\overline{9}.6$	0.012	
5.	»	»	15	5	16	0.029	
6.	»	»	10	10	$3\overline{2}$	0.065	

It will be seen from these experiments that a concentration of alcohol of below 10 % does not disturb the proteolytic capacity of gastric juice.

Experiment 8.

Contents of stomach of man, 36 years of age, suffering from achylia gastrica. 180 c.cms. of contents of stomach obtained, showing HCl 0(2). A.7. $P_H = 3.5$.

	M.	Egg.	Water	Alc.	Alc. in %	Weight in grms.
1.	10	0.085	20	0	0	0.073
2.	»	»	19	1	3.2	0.073
3.	»	»	18	2	6.4	0.073
4.	»	»	16	4	12.8	0.083
5.	»	»	15	5	16	0.084
6.	»	»	—	20 beer	1.3	0.073

In thermostat for 36 hours.

Experiment 9.

Contents of stomach of man 40 years old, who had drunk a good deal of alcohol. Ewald: HCl 30. A.41.

		Alc. in %	*Pep. cap.*
1.	10 solution of egg + 6 water	0	0 %
2.	» » » » + 5 » + 1 water	0	45 »
3.	» » » » + 5 » + 1 cognac	3	47 »
4.	» » » » + 5 » + 1 alc.	6	51 »
5.	» » » » + 5 » + 1 claret	1/2	19 »

Experiment 10.

Contents of stomach of woman 40 years old. HCl 36. A.36

		Alc. in %	*Pep. cap.*
1.	10 solution of egg + 4 water + 1 water	0	0 %
2.	» » » » + 4 M + 1 »	0	65 »
3.	» » » » + 4 M + 1 cognac	3.3	70 »

In thermostat 1 hour. After remaining in thermostat for 16 hours the peptic capacity found to be = 93 %.

Experiment 11.

Man, 20 years of age, normal digestion. Contents of stomach showed HCl 35. A.65.

					Alc. %*)	Pep. Cap.
1.	10 solution of egg	+ 5 water		+ 5 water	0	0 %
2.	» » » »	+ 5 M		+ 5 »	0	75 »
3.	» » » »	+ 5 »	+ 5 alc.		25	0 »
4.	» » » »	+ 5 »	+ 5 aquav.		12.5	64 »
5.	» » » »	+ 5 »	+ 4 Alc.	+ 1 water	20	0 »
6.	» » » »	+ 5 »	+ 3 »	+ 2 »	15	35 »
7.	» » » »	+ 5 »	+ 2 »	+ 3 »	10	68 »
8.	» » » »	+ 5 »	+ 1 »	+ 4 »	5	72 »
9.	» » » »	+ 5 »	+ 0.5 »	+ 4.5 »	2.5	75 »
10.	» » » »	+ 5 »	+ 0.25	+ 4.75	1.25	78 »

From these experiments it appears that the pepsin in the gastric juice cannot bear a higher concentration of alcohol than 10 %, at which limit a reduced proteolytic capacity makes itself evident.

At the 20 % limit all peptic power appears to have disappeared. This, as will be seen, is in accordance with the investigations of Chittenden, Buchner and others. This effect depends upon the precipitative powers of alcohol upon the albumen in the pepsin.

IV. The Relation of Alcohol to the Secretion in the Stomach and the Composition of the Contents of the Stomach with Direct Effects in the Stomach.

The following experiments were carried out in order to investigate the effect of alcohol upon the conditions of secretion in the stomach with ordinary test breakfasts and specially rich (fat) meals.

There is a wide-spread notion to the effect that alcohol has a stimulating effect upon the work of digestion. In order to study the effects of a dram upon digestion we could not very well restrict ourselves to the ordinary test breakfast with thin tea, water and wheaten bread, at it is not customary to take a dram with such light fare, which needs no extra stimulant

*) In the last experiments the percentage of alcohol is given too high, as we estimated with 100 % alcohol instead of 96.20 %.

to bring about digestion. We had, therefore, to procure *fat* in such large quantities that it actually had a nauseating effect and thus see whether digestion proceeded better with than without a dram. A few experiments would not suffice. A whole series would be necessary in order to elucidate the question from as many sides as possible.

The following 52 experiments must, therefore, be regarded merely as a slight contribution towards the elucidation of the question. The experiments were made with various persons, sick and healthy, mainly convalescents in the medical section at Ullevaal and in the medical policlinic at the Riks Hospital. About one half were given test breakfasts with *fat*, whilst the other half had ordinary breakfasts.

The experiments with fat were carried out as follows: —

1st day. *Test meal I.* 30 grms. wheaten bread, 75 grms. fresh dairy butter and 250 c.cms. thin tea.

2nd day *Test meal II.* 30 grms. wheaten bread, 75 grms. fresh dairy butter, 235 c.cms. thin tea and 15 c.cms. aquavit (Paulsen's 10 years old).

Sufficient butter was employed to have a nauseating effect. It also appeared that the quantity of butter was so nauseating that some of the patients could not eat, and therefore the amount had to be reduced (see further experiments). As salt in the butter counteracts nausea, only unsalted butter was used.

Alcohol was given to the patient without telling him what it was. It was served in a medicine glass in the middle of the meal. The female patients thought it had almost a «nasty» taste, whilst the men thought if tasted «like a dram».

In these experiments the amount of alcohol in the whole meal was 2.15 %. The ordinary breakfasts were composed as follows: —

1st day. *Test I.* 250 c.cms. warm water and 40 grms wheaten bread.

2nd day. *Test II.* 235 c.cms. warm water and 40 grms. wheaten bread 15 c.cms. aquavit.

The persons experimented upon were divided into various groups: —

1st group comprised *normal persons* having no digestive troubles. Of these there were 16 in all. 8 were given the «rich» meal, whilst the other 8 were given the ordinary test breakfast with and without spirits (dram)

The 2nd group comprised patients with *ulcus ventriculi.* There were 5 of these, 2 of whom received the «rich» meals and 3 the ordinary meal without fat.

The 3rd group comprises patients with *cancer ventriculi,* all 5 of which received the «rich» meals.

The 4th group comprised patients with dyspepsia. There were 12 of these, 7 of whom received the «rich» meal and 5 the ordinary meal.

The 5th group comprises patients with *achylia grastrica* and *gastritis anacida.* Of the 7 persons in this group, 3 received the «rich» meal and 4 the ordinary meal.

1. Test meals with and without alcohol.

(a) («Rich» meals.)

Experiment 12.

The subject of the experiment was a man, 45 years of age, who had been in the habit of drinking alcohol regularly, but not to excess.

I. Test meal. He took 15 minutes to get all the food down as the butter had a somewhat nauseating effect. It was recovered after 30 minutes (45 minutes after he began to eat). 175 c.cms. light, yellow somewhat fatty liquid mixed with a little slime. HCl 21. A.32. Pep. 66 %.

II. Test meal. (Next day) with alcohol. He again took 15 minutes to eat, but stated that «it went down better» that time. After 30 minutes (45 minutes respectively, recovered 240 c.cms. of similar appearance as that described above. HCl 30. A52. Pep. 70 %.

Test meal No. II with alcohol must be seen to show a slightly better result than test meal I without alcohol. For in the first instance there is a higher degree of acidity which appears to indicate an increased secretion of gastric juice.

Experiment 13.

Man, 43 years of age, somewhat neurotic. Had not drunk alcohol previously. An Ewald test breakfast some days beforehand gave HCl 25. A.65. Removed after 1 hour.

Test Meal I. He took 10 minutes over the meal. Only 50 grms of butter, 250 c.cms. of tea and 35 grms of wheaten bread, 155 c.cms. removed, fairly well digested, light in colour, after filtration, fairly clear liquid. HCl 27. A.50. Slime —. Pep. 75 %.

Test Meal II. As above. Removed 125 c.cms. not quite as clear liquid as above. HCl. 41. A.61. Slime — Pep. 85 % Somewhat less, in the stomach but greater peptic capacity and higher figure for acidity

Experiment 14.

Woman, 27 years old. Healthy, but slighty anaemic.
Test Meal I. Removed 120 c.cms. HCl. 20. A.45.
Test Meal II. » 150 » HCl 28. A.48.
Increase in acidity and contents of stomach in test II. This may possibly be interpreted as increased secretion.

Experiment 15.

Man, 40 years of age, healthy. Had regularly consumed a little alcohol. Does not like aquavit, which he rarely or never drinks. The only liquor he drinks is gin. Otherwise drinks bok øl (Norwegian porter) and wine.
Test Meal I. (50 grms. of butter) Removed 200 c.cms. HCl. 20. A.46.
Test Meal II. (50 grms. of butter) 200 c.cms. HCl. 20. A.46.

Experiment 16.

Woman, 26 years. Healthy.
Test Meal I. Eaten in 7 minutes. The breakfast tasted «fairly good». Removed 80 c.cms. Contents of stomach slightly brown in colour. HCl. 28. A.52. Pep. 65. %.

Test Meal II. This time took 8 minutes. Less nausea after she had taken alcohol. Removed 75 c.cms. HCl. 26. A.46. Pep. 62 %.

As a rule she does not drink alcohol and specially dislikes spirits. She stated that she had a feeling that during Test Meal II she had less nausea. The peptic capacity is stated somewhat too low in both tests as they remained for too short a time in the thermostat.

Experiment 17.

Man, 25 years, healthy.

Test Meal I. Removed 125 ccms. HCl. 30. A.52. Slime — Pepsin. 62 %.

Test Meal II. Removed 85 ccms. HCl. 54. A.74. Slime — Pepsin 70 %.

The experiment was repeated with same result. There is an increase in figure for acidity in test meal II, indicating an increased gastric secretion. Stated that he ate second meal with more appetite and felt less nausea.

Experiment 18.

Man 48 years. Healthy.

Test Meal I. He ate the «fat» but with difficulty on account of nausea. Removed 210 ccms. HCl. 22 A 43. Pep. 62 %.

Test Meal II. Removed 250 ccms. HCl 32. A.54. Pepsin 78 %

This experiment was repeated by one of the physicians of the section, who found HCl. 23, A.45 in test I and HCl. 33 and A.55, in test II, and same peptic capacity. As will be seen the results of the two experiments agree in all respects. The alcohol appears to have increased the secretion, for the increase can scarcely be said to be an accident, since the same figures were found in the check experiment.

Experiment 19.

Man, 53 years old, placed in hospital for gall stone, but at the time in question no symptoms of that complaint and otherwise quite healthy.

Test Meal I. Removed 75 ccms. HCl. 26, A.54. Pep 82 %

Test Meal II. Removed 150 ccms. HCl. 47. A.66. Pep. 92 %

In test II the contents of the stomach removed were double as large and amount of acidity almost double.

Experiment 20.

(b) **Ordinary test breakfast without fat.**

Woman, 33 years of age. Never drinks alcohol.

Test Breakfast I. Removed 245 ccms. HCl 15. A.35.

Test Breakfast II. Removed 280 ccms. HCl 27. A.46.

Some increase in amount of contents of stomach (from 245 to 280 ccms). It is noteworthy that the increase in amount of acid is about double, from HCl 15 in test I. to HCl 27 in test II.

Experiment 21.

Labourer, 21 years old, healthy.

Test Breakfast I. Removed 250 ccms of which 75 ccms precipitate, HCl. 38, A.57.

Test Breakfast II. Removed 320, Precipitate 75, HCl. 40. A. 60.

Before the breakfasts there were removed on the two days in question 50 ccms (HCl. 24, A.43) and 40 ccms (HCl. 17 A.33).

In test II. the amount removed measured from 250 ccms to 320 ccms. Quantity of acid also increased.

Experiment 22.

Man, 27 years old. Formerly had dyspepsia, now well.

Test Breakfast I. (Before breakfast removed 25 ccms. HCl. 30. A.45). Removed 175 ccms. HCl. 47. A.77.

Test Breakfast II. (Before breakfast removed 35 ccms. HCl. 20. A.32). Removed 200 ccms. HCl. 50. A.70.

An increase in contents of stomach in test II.

Experiment 23.

Man, 30 years old. Formerly had dyspepsia. Now well.

Test Breakfast I. Removed 215 ccms. HCl. 25 A.43.

Test Breakfast II. Removed 250 ccms. HCl. 42 A.62.

By giving aquavit at the test breakfast we have in this experiment a considerable increase both in contents of stomach and figures for acid, a rise respectively of 20 % and 70 %.

Experiment 24.

Man, 60 years old, healthy.

Test Breakfast I. Removed 100 ccms. HCl. 42. A 72

Test Breakfast II. » 260 » » 50. A. 76

In Test II the contents of stomach are double, the quantity being 260 ccms, whilst in the first test it was only 100 ccms.

The figures for acid also increase.

Experiment 25.

Woman 22 years. Parturition three weeks before (still-born child). Healthy.

Test Breakfast I. Removed 180 ccms. HCl. 25 A.67

Test Breakfast II. » 235 » HCl. 31 A.50

Increased gastric secretion.

Experiment 26.

Man, 39 years old, slightly neurotic but otherwise healthy. Had drunk a little alcohol.

Test Breakfast I. Removed 150 ccms. HCl. 49. A.70

Test Breakfast II. » 175 » HCl. 67. A.86.

There is an increase in contents of stomach, and also particularly in quantity of acid in Test II.

Experiment 27.

Woman 62 years old, healthy.

Test Breakfast I. Removed 110 ccms. HCl. 37. A.62.

Test Breakfast II. » 190 » HCl. 37. A.59.

A considerable increase in contents of stomach in Test II. almost double. The figures for acid are the same in the two tests.

The following table gives a summary of the results of the experiments recorded above.

Test Meals without fat.

	Without alcohol.			With alcohol.		
Experiment No.	Rec. in ccms.	HCl.	A.	Rec. in ccms.	HCl.	A.
1.	245	15	35	280	27	46
2.	250	38	57	320	40	60
3.	175	47	77	200	50	70
4.	215	25	43	250	42	62
5.	100	42	72	260	50	76
6.	180	25	67	235	31	50
7.	150	49	70	175	67	86
8.	110	37	62	190	37	59

Test Meals with Fat.

	Without alcohol.			With alcohol.		
Experiment no.	Rec. in ccms.	HCl.	A.	Rec. in ccms.	HCl.	A.
1.	175	21	32	240	30	52
2.	155	27	50	125	41	61
3.	120	20	45	150	28	48
4.	200	20	46	200	20	46
5.	80	28	52	75	26	64
6.	125	30	52	85	54	74
7.	210	22	43	250	32	54
8.	75	26	54	150	47	66

In using these results for the estimation of the effects of alcohol upon the secretion of gastric juice, and its composition, it should first be observed that the contents of the stomach recovered of course do not give any absolute measure of the quantity of the secretion itself. Even if we assume that all the contents was recovered, there may of course, even after so short a period as half and hour, have passed small or even considerable quantities through pylorus. It is not impossible that this to a considerable extent may have taken place in the experiments with alcohol with a possible reflex released by reason of its irritative effect upon the mucuous membrane. Therefore the quantity of the contents of the stomach does not give a correct expression for increased or decreased secretion.

The results concerning the free HCl and the total acidity must be regarded as of greater absolute importance. Yet as concerns these results, just as in the case of the quantity of secretion, it must be admitted that even with the same individual, and under strictly uniform experimental conditions, variations may take place from day to day. However the two experiments Nos. 17 and 18 where repeated determinations were made, show striking agreement. The general experience with test meals also indicates that the quantity of HCl and the total acidity in unchanging conditions of experiment are remarkably constant.

As a check, a number of experiments were made in order to ascertain whether the quantity of the contents of the stomach and the figures for acidity varied appreciably from one day to another. I have gone through in all eighty test breakfasts, the majority of which were taken two days in succession. Some were taken with a few days interval and others again at intervals of a few weeks. We give here the results of twenty test breakfasts with twenty different patients, when the contents of the stomach were removed with two days interval.

No.	Sex.	Age	Removed in ccms.		HCl.		A.	
			1 day	2 days	1 day	2 days	1 day	2 days
1	Man	54	150	140	0	0	18	16
2	»	41	130	135	0	0	24	25
3	»	25	125	120	30	30	74	72
4	»	48	210	220	32	33	54	52
5	»	32	110	110	6	5	31	28
6	»	53	145	150	36	38	73	75
7	»	57	55	75	38	35	64	64
8	Woman	33	120	120	50	52	80	82
9	»	50	130	125	25	24	58	60
10	»	18	165	175	10	8	40	39

Of the above patients, the first two were cancer patients, the others with more or less serious symptoms of dyspepsia. In these experiments exactly the same times and same composition for the test breakfasts were used.

In the other thirty patients from Ullevaal Hospital there were found fairly exactly the same conditions, in spite of the circumstance that the experiments were carried out at intervals of days and even weeks. Only two of these patients displayed any marked deviations in the two tests. One in whom differences were seen from one day to another was a patient suffering from nervous dyspepsia, a case of heterochyli. The patient in question, a young girl, was examined several days in succession, but with constant differences in the amounts of secretion and acid. This case is a good instance of how cautious one should be in drawing too wide conclusions from an isolated experiment with these conditions.

A glance at the table showing the results of the experiments with *fat-free* test meals shows that in all cases there was found to be an increase in the contents of the stomach under the effects of alcohol, but that there is no question of any constant effects. In some cases (3, 4 and 7) there were respectively 12,6, 16,3 and 16,6 %, and in experiment 4 there was less than 1,60 %. The same variations are shown in the case of the quantity of acid. In one case there was no difference at all between the quantities of free HCl (Experiment 8) and in two cases (2 & 3) the difference is very small, whilst in experiment I it is very considerable. The same applies to the total acidity. In three of the eight experiments, there is even less in the experiment without alcohol than in the corresponding experiment with alcohol, and in only one case is it considerably larger in the alcohol experiment than in the experiment without alcohol.

In the experiments with a very rich (fat) test meal, the variations are even greater. In three of the eight experiments (2, 5 and 6) the contents removed from the stomach are less in the experiment with alcohol than in that without. In one case (5) they are equal, and in the four others are increased, but only in two cases (1 and 8) by considerable amounts.

Quite similar conditions are here exhibited by the free HCl. In one case (5) is less in the experiment it with alcohol than in that without alcohol, in one case (4) it is unchanged, and in the other cases it is increased and generally more than in the experiments with the test meal without fat. The total acidity in one case (5) is less in the experiment with alcohol than in the corresponding experiment without alcohol, in one case (4) it is quite the same, and in the others there is an increase also in this respect.

In all these experiments it is shown that the gastric juice secretion in different individuals is affected in highly different ways. Whilst in some it is reduced by the effects of alcohol, in others it is unaffected, and again with others increased. From the determinations here before us it would appear that the last named effect is the most frequent, and that in certain cases it may attain to quite considerable degrees; but as regards the variable results the existing number of experiments is too small for any definite conclusion to be drawn from them.

2. The effect of alcohol upon diseases of the stomach.

I have not been able to find in medical literature that any special experiments have been made with alcohol in various affections of the stomach.

On the other hand medical literature contains a number of statements regarding alcohol as the *cause* of various diseases of the stomach, such as *chronic gastritis, ulcus ventriculi,* and *cancer ventriculi.*

K. Faber (43) states concerning chronic gastritis, that it is the degree of alcohol which decides whether in chronic alcoholism there is chronic gastritis or not. In a later work he states that the most frequent cause of chronic gastritis is not intoxication, chronic alcoholism, or secondarily by infection, but that the chief cause is a bad condition of the teeth.

Crämer (35) in his lectures on chronic gastritis says that alcohol is very seldom a cause of that complaint. It is only certain spirit drinkers who contract chronic gastritis. *Fahr* (47) arrives at another result, for he considers that the abuse of alcohol must be placed in the front rank as a cause of gastritis.

Vogelius (165) found amongst 83 chronic alcoholism patients, that 40 of them showed signs of dyspepsia, the rest were without gastric symptoms. *Martens* (103) carried out investigations similar to those of Vogelius and found that one half of his patients suffering from chronic alcoholism had a reduced amount of HCl in the stomach. The same was also found by *Hoppe-Seyler* (75) and *Foster.* (50) The latter divides drunkards into two categories, one with chronic gastritis and the other with dyspepsia accompanied by reduced secretion. Eisenhardt (41) obtains a similar result.

Quensel (134) states that his experience is that pathological anatomy does not know of any changes in the stomach which have arisen as the result of a moderate consumption of alcohol.

Dujarden-Baumetz and *Audigé* (39) by experiments on swine were unable to find any microscopic alternation of the mucuous membrane of the stomach in abuse of alcohol. *Braun* (23) found the same in dogs and rabbits, likewise *Fahr* (47). On the other hand *Herbert* and *Aubertin* (67) found alterations both in the ventricular epithelium and in the tissue with continued use of alcohol. A similar discovery was made by *Straus* and *Blocq* (154) and also Chretien (29), whilst *Kahlden* (84) was unable to demonstrate any such alterations in the mucous membrane of the stomach.

Besides the question of alcohol as a cause of chronic gastritis, writers in medical literature have occupied themselves with alcohol as an ætiological factor in *ulcus ventriculi* and *cancer ventriculi*. *De la Tourette* and *Mathieu* (161) champion this view, which was long since disproved by the investigations of Vogelius, Marten and others. *Mc Connell* (117) and *Owen* (125) have also proved by statistics that there is no connection between the abuse of alcohol and the said disease of the stomach.

Sternberg (153) attempted to produce gastric ulcer in guinea pigs by introducing (with probe) concentrated doses of alcohol into the stomach, experiments which are not of any great practical importance.

Baer (5) states regarding alcoholism and cancer, that cancer ventriculi is somewhat rare amongst drunkards.

a) Experiments with patients suffering from ulcus ventriculi.

(»Fat« meals).

For the composition of the meals see page 45.

Experiment 28.

Man. 56 years old, chronic gastritis and ulcus callosum ventriculi. Cancer?

Test Meal I. (50 grammes dairy butter). Took 15 minutes to eat, and the gastric juice was recovered thirty minutes later. Recovered 200 ccms, showing HCl.O. A.6. Uff —. Blood —. Pep. O.

Test Meal II. Again took fifteen minutes to eat meal. There was recovered 200 ccms. HCl 0. A.6. Pep. 0 and otherwise as above.

Experiment 29.

Woman, 55 years old, a long standing ulcus ventriculi. The test meal contained 25 grammes of butter and the time taken to eat it, 10 minutes.

Test Meal I. Removed 80 ccms. HCl. 25, A. 43. Pep. 60 %.

Test Meal II. Removed 160 ccms. HCl. 18, A. 40. Pep. 56. Patient stated that she felt better after Test Meal II than after the first one. In the first test there was a greater acidity but the quantity of the contents of the stomach was only one half of that in the second test.

Experiment 30.

(Ordinary test breakfast without fat).

Man. 39 years old. Røntgen shows normal conditions, but he has had dyspepsia with pains, and formerly suffered from ulcus ventriculi.

Test Breakfast I. Recovered 170 ccms. HCl 62. A. 88 Slime plus, Blood — : Pep. 40 %.

Test Breakfast II. Recovered 175 ccms. HCl 71. A. 93. Slime + Blood. — Pep. 64 %.

Considerable increase in figures for acid which were higher than normal beforehand.

Experiment 31.

Man. 42 years old. At one time drank a great deal of alcohol. (about half a bottle of spirits daily) but less recently. Has had lues and been treated for it several times.

Diagnosis. Ulcus luetic ventriculi.

Test Breakfast I. Recovered 215 ccms. HCl 0. A. 12. Pep. 0.

Test Breakfast II. Recovered 250 ccms. HCl. 0. A. 14. Pep. 0.

In Test II there is an increase in the contents of the stomach. Free HCl cannot be shown, possibly on account of the circumstance that the contents of the stomach were sanguinolent.

Experiment 32.

Man. 43 years of age, ulcus ventriculi. Cancer.

Test Breakfast I. Recovered 180 ccms. Sanguinolent. HCl. 0. A. 4,

Test Breakfast II. Recovered 150 ccms. Sanguinolent. HCl 0. A. 3.

Peptic capacity in both tests = 0.

The contents of stomach in Test II were somewhat less, otherwise there is neither free HCl nor peptic capacity in either of tests.

Table giving general results.

(Ulcus ventriculi).

I. Test Meals without fat.

	Without alcohol.			With alcohol.		
No.	Recovered.	HCl.	A.	Recovered.	HCl.	A.
1.	170	62	88	175	71	93
2.	215	0	12	250	0	14
3.	180	0	4	150	0	3

II. Test Meals with fat.

	Without alcohol.			With alcohol.		
No.	Recovered.	HCl.	A.	Recovered.	HCl.	A.
4.	200	0	6	200	0	6
5.	80	25	43	160	18	40

The table shows that in three of the five tests there is an increase in the contents of the stomach when alcohol is used, in one case the amount is the same and in one case it is reduced. The free HCl is increased in one case and diminished in one case. In the remaining three cases it has not been possible to show the presence of free HCl. As mentioned above two of these latter were doubtful cases of cancer.

b) Patients with Cancer Ventriculi.

(Fat Meals).

Experiment 33.

Man. 63 years old with cancer ventriculi.
Test Meal I. Only 30 grammes butter given, as patient could not manage to get more down. 150 ccms. recovered of slimy contents of stomach. HCl 0. A. 15 Uff + Sanguis +
Test Meal II. Recovered 150 ccms. HCl. O. A. 10.

Experiment 34.

Man. 54 years old, cancer ventriculi. General condition on entering hospital fairly good, but patient losing weight and dyspeptic.

Test Breakfast I. Ate for seven minutes and test removed 37 minutes later. Recovered 150 ccms. HCl 0. A. 18. Uff + Sanguis + Pep. +

Test Breakfast II. On this occasion ate for nine minutes and contents removed after 39 minutes. 120 ccms. of thick porridge-like gastric contents. HCl 0. A. 16. otherwise as above. No essential change. Patient died half a year later of cancer ventriculi.

Experiment 35.

Man. 41 years old, with cancer ventriculi. He died three months later. On entry was very anæmic and was entered with the diagnosis: anaemia perniciosa.
Test Breakfast I. Recovered 130 ccms. HCl 0. A 24. Uff + Sanguis. +
Breakfast II. Recovered 175 ccms. HCl 0. A. 11. Uff + Sanguis +.

Experiment 36.

(Without fat).

Man. 53 years old with cancer ventriculi, from which he died two months after entering that section of the hospital.

Test Breakfast I. Recovered 150 ccms. HCl 0 A. 10. Uff + Sanguis + Slime + Pep. 0.
Test Breakfast II. Recovered 150 ccms. HCl 0 A. 10. Uff + Sanguis + Pep. 0.

Experiment 37.

Man. 57 years old, cancer ventriculi, with palpable tumour in the epigastrium.
Test Breakfast I. Recovered 50 ccms. HCl 0. A. 15. Uff + Sanguis + Slime + Pep. 0.
Test Breakfast II. Recovered 150 ccms. HCl 0. A 15. Otherwise as above. He felt better after test II.

Table giving general results

(Cancer ventriculi).

Test Meals without fat

	Without alcohol.			With alcohol		
No.	Recovered.	HCl.	A.	Recovered.	HCl.	A.
1.	150	0	10	150	0	10
2.	50	0	15	150	0	15

Test Meals with fat.

3.	150	0	15	150	0	10
4.	150	0	18	120	0	16
5.	130	0	24	·175	0	11

The above table shows that the alcohol has had no influence upon the secretion of gastric juice, either in amount or secretion.

Some of the patients in question stated that they seemed to digest their food better with alcohol than without. These statements can of course only be taken as an expression of a subjective feeling of relief or of less pain during the stay of the food in the stomach. From the above experiments this relief must be due to other causes than a real increase in digestive work. To some extent it may be due to the narcotic effects of alcohol, but in many cases it may also be due to a diminution of fermentation in the stomach. In some cases I have tried to prove the latter by keeping tests with and without alcohol in the thermostat for 48 hours. It then appeared that the total acidity was less in the gastric juices to which alcohol had been added, for the total acidity increases in the gastric juice when left standing, the acid fermentation continuing with the formation of increased quantities of fermentation acids (lactic acid, butric acid etc.). Alcohol had a somewhat retardative effect upon this fermentation, and in cancer patients with *marked retention* it may possibly play a part. They themselves state that the eructations were not so troublesome and malodorous as before, and that there *is less pain*. The fact that alcohol has the effect of relieving pain is very important one with these patients, for they are very grateful for the slightest relief. I have used alcohol, one dram 3 times a day, with the meals of a number of incurable cancer patients and found that they could manage for a long time without morphia in that way. It may therefore at times be useful to try alcohol with cancer patients. Probably the best effects are obtainable from aquavit, cognac and whisky, according to the patients taste. Wine and beer appear to be of less use, or often of no use at all, a subject to which I shall return later.

c) Patients with dyspepsia.

(Fat meals).

Experiment 38.

Man, 30 years of age with slight dyspeptic troubles. Only 30 grms of butter used. On both occasions he ate the meal in 10 minutes and 35 minutes after there were removed 75 c.cms.

HCl 40. A. 64. Pep. 70 % in Test Meal I and 160 ccms, HCl 37. A. 57. Pep. 66 % in Test Meal II.

In test II the contents of the stomach had increased to about double; otherwise practically no change.

Experiment 39.

Woman, 21 years of age, some dyspepsia. Had not previously taken alcohol. There are some signs of hysteria.

Test Breakfast (Ewald) Recovered 75 ccms. HCl 15. A 40. Pep. 70 %.

Test Breakfast I. Recovered 150 ccms. HCl 18. A 35. Pep 70 %
Test Breakfast II. » 130 » » 19. » 46 » 70 %.

No essential difference. The experiments were carried out 3 days in succession.

Experiment 40.

Man, 19½ years old, placed in hospital for ulcus ventriculi, but only showed signs of dyspepsia (nervous dyspepsia).
Test Breakfast I. Recovered 220 ccms. HCl 23. A 55. Pep. 75 %
Test Breakfast II. « 175 « « 26. « 46. « 75 %.
Test Breakfast (Ewald) had previously given HCl 0. A 30. One month later the experiment was repeated.
Test Breakfast I. Recovered 220 ccms. HCl 23. A 54. Pep. 75 %.
Test Breakfast II. « 180 « « 25. « 45. « 75 %.
Contents of stomach less in test II.

Experiment 41.

Man, 33 years old. Has suffered from dyspepsia for several years. There was no retention (with Bourget). Test Breakfast (Ewald) some months before showed HCl 50, A 82, Pep. 94 %.
Test Breakfast I. Recovered 90 ccms. HCl 58. A 72. Pep. 98 %.
Test Breakfast II. « 120 « « 46. « 57. « 94 %.
In this case the alcohol appears to have increased the contents of the stomach, whilst both the free HCl and the total acidity are diminished.

Experiment 42.

Man, 50 years old, total abstainer. Has suffered from dyspepsia for some time. Lay in the ward for sciatica and in addition suffered from nervous dyspepsia.

Test Breakfast I. Recovered 75 ccms. HCl 25. A 58. Pep. 74 %.
Test Breakfast II. « 140 « « 34. « 67. « 80 %.

In test II double the quantity of contents of stomach removed as compared with I. There is also an increase both in the free HCl and in the total acidity.

Experiment 43.

Man, 32 years old, extremely neurotic. Had not been able to work for that reason. Spermatorrhoea. Diagnosis — Dyspepsia nervosa. Test Breakfast (Ewald) Recovered 150 ccms. HCl 8. A 35. Pep. 85 %.

Test Breakfast I. Recovered 200 ccms. HCl 10. A 38. Pep, 86 %.
Test Breakfast II. « 200 « « 7. « 32. « 83 %.

Both the free HCl and the total acidity are diminished in experiment II.

Experiment 44.

Woman, 26 years old. Has suffered from dyspepsia for about 5 years, occasional vomiting, no pain.

Test Breakfast I. Recovered 150 ccms. HCl 0. A 20. Pep. 46 %.
Test Breakfast II. « « « « 25. « 45. « 85 %.

In the first test there is no trace of free HCl, whilst in test II it is about normal.

I have not had an opportunity of checking these results. It is conceivable that it is a case of *heterochyli,* and that it is not only the alcohol which has effected the considerable improvement in her digestive powers in test II.

Experiment 45.

(Without fat).

Woman, 54 years old, has several times had attacks of cholalithiasis. At time of experiments no pain, no icterus, only slight dyspepsia. Motions sluggish.

Test Breakfast I. Recovered 45 ccms. HCl 68. A 89. Pep. 93 %.
Test Breakfast II. « 85 « « 67. « 88. « 95 %.
In test II the contents of the stomach are double of those in test I, but the quantity of HCl and the total acidity are unchanged.

Experiment 46.

Woman, 20 years of age. For some time has vomited her food. Diagnosis: Dyspepsia (ulcus ventriculi?).
Test Breakfast I. Recovered 200 ccms. HCl 35. A 65.
Test Breakfast II. « 230 « « 42. « 58.
There is some increase in the quantity of gastric juice and of the free HCl in test II.

Experiment 47.

Man, 21 years old. Has had pains in the epigastrium for about 2 years. Good appetite, sluggish motions. Diagnosis: Dyspepsia.
Test Breakfast I. Recovered 20 ccms. HCl 58. A 80. Pep. 62 %.
Test Breakfast II. « 155 « « 66. « 92. « 74 %.
A considerable increase in the contents of the stomach recovered in test II, and there is also an increase in the free HCl and the total acidity.

Experiment 48.

Man, 27 years old. Three weeks before he had a pain in his chest and in stomach with fleeting pains. He vomited both morning and evening. Had drunk a great deal before, but drinks less now. Diagnosis: Dyspepsia hyperchlorhydria.
Test Breakfast I. Recovered 300 ccms. HCl 58. A. 84.
Test Breakfast II. « 225 « « 63. « 85.
Before the breakfasts there were recovered 75 and 100 ccms respectively. There is thus considerable hypersecretion present. In test II the contents of the stomach are less than in test I. There was also present chronic gastritis with rather profuse slime in both tests. In addition he suffers from hyperchlorhydria

and retention, and therefore the objection may be made to the experiment that the stomach when flushed was not properly emptied.

Experiment 49.

Man, 37 years of age. Had dyspepsia (ulcus?) at 20 years of age. Unable to retain his food and vomits, motions sluggish. Diagnosis: Dyspepsia hyperchlorhydria.

Test Breakfast I. Recovered 220 ccms HCl 44 A 72
Test Breakfast II. « 240 « « 48 « 74

Practically unchanged condition. Patient had previously consumed a good deal of alcohol, but no longer does so.

Table of general results

(dyspepsia).

I. Tests Meals without Fat.

	Without alcohol.			*With alcohol.*		
No.	Recov.	HCl	A.	Recov.	HCl	A.
1.k.	45	68	89	85	67	88
2.k.	200	35	65	230	42	58
3.m.	20	58	80	155	66	92
4.m.	300	58	84	225	63	85
5.m.	220	44	72	240	48	74
			II. Test Meals with Fat.			
6.m.	75	40	64	160	37	57
7.k.	150	18	35	130	19	46
8.m.	220	23	55	175	26	46
9.m.	90	58	72	120	46	57
10.m.	75	25	58	140	34	67
11.m.	200	10	38	200	7	32
12 k.	150	0	20	150	25	45

In the above-mentioned test meals without fat, there was found in cases 4 an 5 an increase in the contents of the stomach in meals with alcohol. In one case only was a diminished quantity found. As regards the free HCl and total acidity there was found an increase in the meal with alcohol in three cases

(3, 4 and 5) whilst in the other two cases the conditions were practically unchanged. In the test meals with fat there was found an increase in the amount of gastric juice in three cases where alcohol was used (6, 9 and 10) a diminished amount in 2, (7 and 8) and in two cases unaltered conditions (11 and 12).

As regards the free HCl and the total acidity, there is an increase in two cases (10 and 12) where alcohol was used, and a diminution in two cases (6 and 11) whilst the other cases are practically unchanged.

With respect to patients with nervous dyspepsia, this table appears to show that sex and age play a certain part. In young men and women alcohol does not appear to increase the quantity of contents of the stomach or the amount of gastric juice. Experiment 12 forms an exception. In certain cases (3, 5, 6, 9 and 10), on the other hand, the increase in the contents of the stomach in meals with alcohol may be quite considerable, thus about 100 % and upwards, which may possibly indicate a retarded evacuation.

We should be inclined to believe that the psychic effects may play a part here, for many women patients do not like alcohol, at any rate in so concentrated a form as aquavit, and this repugnance may conceivably have a psychic effect upon the secretion of gastric juice.

d) Patients with achyli and anacid gastritis.

(Meals with fat).

Experiment 50.

Man. 62 years old. Was in hospital a year before, and investigation after a test meal showed.
HCl O. A.12. Pep.14 %. He suffers from »Anacid gastritis«.

Test Breakfast I. Recovered 100 ccms HCl O. A 21. Slime + Uff — Pep.13 %.

Test Breakfast II. Recovered 70 ccms HCl 10. A.26 Slime + Uff — Pep.68 %.

That is to say, *with* alcohol HCl 10, without alcohol HCl 0. *As this result was very striking the experiment was repeated a week later, so that test meal II was given first on that occasion and test meal I a day later.*

Test Meal I. Recovered 200 ccms HCl 3. A.20 (i.e. there is now distinct HCl reaction).

Test Meal II. Recovered about 200 cmms HCl 0. A.16 (also this time no demonstrable HCl reaction).

As will be seen the results of the two experiments agree in all essentials. In both cases the specimens recovered contained free HCl when *alcohol* was used, but none in tests without alcohol.

Experiment 51.

Woman. 42 years old, has practically speaking never consumed alcohol.

Diagnosis: gastritis chronica anacida.

Test Meal I. Could not manage to eat more than 15 grammes of butter as it made her feel very sick. Recovered 80 ccms HCl.0. Uff — Slime + A.30.

Test Meal II. She then ate double as much butter (amount 30 grammes) as it »went down« so much easier« with aquavit. Recovered 100 ccms HCl 5. A.20. Uff — Slime + (with HCl gave 8). In order to check the positive find of free HCl in test II, the patient was given three different Ewald Test breakfasts, all of which showed HCl = 0.

As in the former experiment there was also found free HCl in the meal *with* alcohol, whilst in the other test breakfasts no free HCl was demonstrable.

Experiment 52.

Man, about 60 years, looked well. Diagnosis gastritis chronica et enteritis, as many as 10 — 12 motions in 24 hours, now and then also vomiting.

Test Breakfast I. Recovered 100 ccms HCl 6. A 31. Slime +
Test Breakfast II. « 110 « « 5. A 28. Slime +

The quantity was increased but the amount of HCl and total acidity was, if anything, slightly diminished. In hospital he was only given aromatic tinctures and HCl drops and recovered admirably.

Experiment 53 (without Fat).

Man. 44 years old. Had pains after meals for several years. No vomiting, motions in order. He is thin and pale. Diagnosis: Gastritis chronica anacida.

Test Breakfast I. Recovered 100 ccms HCl 0. A.8. Sanguis + Slime + Uff. +

Test Breakfast II. Recovered 95 ccms HCl 0. A.7. Sanguis + Slime + Uff. +

Results uniform in both tests.

Experiment 54.

Man. 39 years old. Had suffered slightly from dyspepsia with vomiting. No pyrose but ructus. Left leg amputated below the hip joint. Had previously lain in hospital for a considerable time for *alcoholism* and *morphinism,* also neurasthenia and sleeplessness.

Diagnosis: gastritis chronica anacida.

Test Breakfast I. Recovered 100 ccms HCl 0. A 2. Slime + Pep.0.

Test Breakfast II. Recovered 225 ccms HCl 0. A 2. Slime + Pep.0.

In both samples recovered there were clots of sanguinolent slime, and the material was almost brown with blood.

The difference between these two tests is that in II we have double as much contents of stomach as in I.

Experiment 55.

Woman. 20 years old. Has had bad digestion for about half a year with pain and has been under treatment without any improvement. Motions varying between loose and sluggish. Diagnosis: achyli.

Test Breakfast I. Recovered 200 ccms. HCl 0. A.13.Pep.0.
Test Breakfast II. Recovered 175 « HCl 2. A.16. « 0.

In this case we distinctly find free HCl in test II with alcohol, a feature absent from the first test. The quantity of free HCl is quite small.

Experiment 56.

Woman. 29 years old, who for 4 or 5 years had had pain in the stomach with vomiting now and then. Diagnosis: gastritis chron: anacida.

Test Breakfast I. Recovered 150 ccms HCl 0. A.7. Slime + Sanguis +

Test Breakfast II. Recovered 60 ccms HCl 0. A.17. Slime + Sanguis +

Considerably less contents of stomach in II than in I. However the blood present in the contents of the stomach interferes with the chemical analysis. The patient has doubtless gastric ulcer as well.

Table shewing general results

(achylia gastrica et gastritis chronica.)

I. Test meals without Fat.

	Without Alcohol			With Alcohol		
No.	Recovered	HCl	A.	Recovered	HCl	A.
1.	100	0.	8.	95	0.	7.
2.	100	0.	2.	225	0.	2.
3.	200	0.	13.	175	2.	16.
4.	150	0.	7.	60	0.	17.
	2. Test meals with fat.					
5.	100	0.	21.	70	10.	26.
6.	80	0.	30.	100	5.	20.
7.	100	6.	31.	110	5.	28.

In the above seven cases 3 (2, 6 and 7) show an increase in the amount of the food recovered in the meal with alcohol in proportion to the meal without alcohol. In the other four cases there is a diminished quantity in the meal with alcohol as compared with the test meal.

It is remarkable that in 3 (3, 5 and 6) of these seven cases, in which there is no demonstrable free HCl in the contents of the stomach in the test meals without alcohol, there is shown to be free HCl in the meal with alcohol. As will appear from the experiments in question, this positive discovery of free HCl in the meal with alcohol was checked by repeated experiments, so that in these cases it does not appear to be an accident, but must be ascribed to the secretion-producing effect of alcohol. As will further appear from the table this effect of alcohol with achyli is not a constant result.

In the other achyli conditions of the above experiments there are various complications which play a part. Thus in three of them we found sanguinolent contents of the stomach, which may possibly be due to an old ulcer, an incipient ulcus cancrosum or violent gastritis with ulcerations of the ventricular mucous membrane.

3. Investigations concerning the effects of considerable doses of alcohol upon the secretion of gastric juice in healthy individuals.

In the above we investigated the effects upon secretion of a constant quantity of alcohol (15 ccms aquavit). The next six experiments were intended to show the effects of alcohol upon secretion when the *doses of alcohol are considerable.* These *experiments were made on healthy persons.*

Experiment 58.

Man. 22 years old. Had dyspepsia troubles now and then. Otherwise healthy.

Test Breakfast I. Recovered 190 ccms. Congo + A.36 Pep. 80 %.
Test Breakfast II. (With 30 grammes aquavit = 14.3 ccms alcohol). Recovered 270 ccms Congo + A.52. Pep.86 %.

With dose of alcohol of 30 grammes aquavit (5 % of the whole test breakfast) we have a considerable increase in the quantity recovered (about 40 %). The free HCl in this experiment and in the next were not determined, but the total acidity has risen.

Experiment 59.

Man. 49 years of age. Had previously taken a dram with his food now and then, but not recently.

Test Breakfast I. Recovered 315 ccms. Congo + A.41.

Test Breakfast II. (With 50 grammes aquavit). Recovered 415 ccms. Congo + A.46.

The quantity recovered from this man was quite large in the first experiment. By the addition of 50 grammes of aquavit it was further increased by about 30 %.

The amount of alcohol in the test breakfest is 8.6 % in this and the following ones. On account of the presence of *material in the stomach* the aquavit is at once weakened and after entering the stomach forms only about 6 % of alcohol in the total contents of the stomach. The alcohol was administered at the end of the test breakfast.

Experiment 60.

Man. Teetotaller, 23 years of age. Healthy.

Test Breakfast I. Recovered 180 ccms. HCl 52. A.71.

Test Breakfast II. (With 50 grammes aquavit taken after the meal). Recovered 190 ccms. HCl 67. A.85.

The peptic capacity was found to be over 90 % in both cases. We here see, as in the preceding experiment, an increase in the quantity of acid, especially the free HCl which is considerably above the normal. It is not possible to demonstrate any direct injurious effects upon the pepsin.

Experiment 61.

Man. 25 years old, healthy.

Test Breakfast I. Recovered 205 ccms. HCl 27. A.52.

Test Breakfast II. (With 50 grammes aquavit taken after the meal). Recovered 205 ccms. HCl 45. A.65.

The peptic capacity was practically equal in both tests, over 90 %. We here find no increase in the amount recovered, but the gastric contents in test II have a considerably higher contents of HCl and total acidity. That is to say about the same effect as that found in the case of the preceding experiment.

Experiment 62.

Man. 23 years old, teetotaller, stated that he was well but as was subsequently found, had suffered from digestive troubles for a long time (gastritis chron. anacida).

Test Breakfast I. Recovered 50 ccms HCl 0. A 11. Slime + Sanguis — .

Test Breakfast II. (With 50 grammes aquavit after meal). Recovered 35 ccms HCl 0. A 7. Slime + Sangius — .

In this man, who suffers from somewhat acute gastritis with copious formation of slime and reduced secretion, we find no very great change in the two tests. In any case there is no improvement after the aquavit. The gastric contents were also so hard and slimy that an exact determination of the peptic capacity could not be made.

Experiment 63.

Man. 26 years old. Healthy.

Test Breakfast I. Recovered 100 ccms. HCl 65 A.89.

Test Breakfast II. (50 grammes aquavit taken before the meal). Recovered 110 ccms. HCl 36 A.69.

In test II the peptic capacity was found to be 30 % and in test I 60 %.

In test II both the free HCl and the peptic capacity are distinctly less, a sign that the digestive capacity has been partially diminished. The 50 grammes of aquavit which were taken *before* the meal have thus had an injurious effect. This may possibly have taken place in the following manner: —

At first there was a higher degree of alcohol in the stomach, viz: 43 %, and digestion was reduced by the secretion being hampered, and the pepsin partially destroyed. However, this did not last long for the secretion was increased after the alcohol had been resorbed and we therefore after a lapse of 30 minutes only find that the gastric contents have become just as large as in the test meal. *But it would appear that during that time it has not been able to counterbalance the injurious effect of the alcohol.* The dose of alcohol was too large and for that reason the degree of alcohol too high.

We have here gone beyond the limits of the dose which a healthy man can take in such a concentrated form without injurious effects. The concentration of alcohol is so high because the dose of alcohol is taken at the commencement of the meal. If the same dose is taken *during* or *after the meal*, we find, as seen in previous experiments, no demonstrable direct injurious effects from the alcohol.

It thus appears that we can also apparently prove the injurious effects of alcohol in the stomach when the degree of alcohol is brought above 20 %. According to the above experiments in vitro, such a degree of alcohol will entirely destroy all peptic capacity, in the gastric juice. But it appears that on account of the secretion of new gastric juice and in part resorption of alcohol, a dilution of the alcohol takes place rather rapidly, so that the disturbance is not as great as it would otherwise be found to be. That is to say, in the course of about 15 minutes the degree of alcohol has been reduced from 43 % to below 10 %.

Table giving general results (Considerable does of alcohol.)

	Without Alcohol			*With Alcohol*		
No.	Recovered	HCl.	A.	Recovered	HCl.	A.
1.	190	—	36	270	—	52
2.	315	—	41	415	—	46
3.	180	52	71	190	67	85
4.	205	27	52	205	45	65

In these four experiments with 50 ccms of aquavit after an Ewald test breakfast, there is an increase in the quantity of secretion in three cases. In all the experiments there is an increase in the total acidity in the meals with alcohol, and in the two experiments in which the free HCl was determined the latter was increased to a considerable extent.

Such a comparatively concentrated dose of alcohol which disturbs the pepsin in the gastric juice, should of course also have an irritating effect upon the *gastric mucuous membrane.* We should be able to find an expression of such irritation of the mucous membrane by an augmented production of mucus.

For this reason especially, in experiment 63, we investigated the amount of mucus in the two samples of gastric juice, in order if possible to prove an increase in the formation of mucus in test breakfast II with 50 grammes of aquavit. But it was not possible to discover any special admixture of mucus. There was no demonstrable slime in any of the tests. *Thus it was not possible to prove any considerable irritation* of the gastric mucous membrane which would evince itself by an increase of mucus in the gastric juice. We may therefore conceive the possibility of a transudation through the mucous membrane without any admixture of mucus.

The gastric juice of the other three persons experimented upon was also carefully investigated for mucus but no increased production of slime was to be found. In experiments 60 and 61 there was practically no slime, either in the »check« breakfast or in the »alcohol« breakfast, but on the other hand in experiment 62, as previously discussed, there was a considerable amount of mucus in both meals with the man suffering from pronounced chronic gastritis. It was not possible to decide with certainly whether there was any increase of mucus in test II in comparison with test I.

V. The Effects of Alcohol upon »Psychic« Secretion.

By *Pawlow's* well-known indications it was shown that the secretion of gastric juice under normal conditions can be produced in two different ways, viz: either by means of a secretory reflex from the olfactory nerves, gustatory nerves or even mere sight, or by means of an influence upon the gastric mucous membrane. As regards the former mechanism, the psychic condition of the central nervous system, as is known, plays an extremely important part, for on the one hand it may result in an increase, and on the other hand a stoppage of the reflex. Indeed purely psychic influences may produce secretion through memories or conceptions.

In judging the effects of alcohol upon the secretion of gastric juice we cannot disregard the circumstance that it may also act by means of a reflex produced by its smell and taste.

In the cases hitherto reported, in which alcohol was drunk at meals, the secretion due to reflexes will naturally go together with that which is due to the effect in the stomach. It is therefore of interest to investigate how far a secretion could be produced by psychic means alone.

The experiments recorded below were conducted with this object in view. As far as can be seen, medical literature contains no investigations on this matter. *Pawlow* (126) who discusses the importance of alcohol as an »appetizer« appears to regard the effects in another way. In his book »Die Arbeit der Verdauungsdrüsen« he says: — «The secretion of gastric juice is dependent upon the effects upon the central nervous system, so that serious reading or conversation at table can reduce it. By very small quantities of alcohol we perhaps have quite a »slight narcosis« of the central nervous system, which helps to liberate people from the depressing influence of the sorrows and worries of the day.«

It would appear from this that he refers the effects of alcohol to a narcotizing influence upon the nervous system, whereby repression of the psychic reflex is diminished or removed.

Miller, Bergeien, Rehfuss and *Hauk* (114) carried out a number of experiments upon the psychic influence of *food* upon the secretion of gastric juice and found that *sight* alone started the secretion if the meal were served in an appetizing manner, and the contrary if it were served in a slovenly and unappetizing manner. *Smell* plays a minor part, and its influence cannot be compared with that of sight. *Touching* food, when the person concerned neither tasted nor saw it, produced no secretion. On the other hand the *thought* of a good meal increased gastric secretion. Bad air reduced secretion. Reading newspapers during a meal did not appear to influence secretion in one way or the other. On the other hand exhausting mental labour reduced secretion considerably.

These experiments confirm similar investigations carried out by Smith, *Holder* and *Hauk,* and also by Cannon (24).

The following experiments were so carried out that any gastric juice that might be present was not recovered until the morning. Thus the Rehfuss tube remained lying in the stomach during the whole time of the experiment and does not appear to have troubled the patient to any extent worth mentioning. Then after the lapse of 15 minutes all the gastric juice procurable was removed by suction through the tube. The tiny metal olive has of course a tendency to place itself in the deepest region of the ventriculi, where any gastric juice present will also be. By causing the patient during the suction to lie on his back, side, and to sit, we obtain practically all the gastric juice. No lavage of the stomach was performed.

There was no dishing or serving of the food which might influence the psychic secretion. The dram or the beer was placed alone on a table by the side of the individual experimented upon.

Experiment 64.

Man. 46 years old, healthy. As a teetotaller he did not specially appreciate aquavit, so that eo ipso it could not be assumed that the mere sight and smell of aquavit would produce any special increase of the psychic secretion of gastric juice.

In the morning whilst fasting there were removed 6.5 ccms of gastric juice before the experiment. The Rehfuss tube was put down and remained lying for about 15 minutes whilst patient lay on a couch and read newspapers. There was then removed the gastric juice which had accumulated in the stomach. After another 15 minutes, during the whole of which time the tube was down in the stomach, he sat on a chair and now and then smelt a dram of aquavit which was placed before him on the table. He then thrice, with five minutes interval, took about 10 ccms of the aquavit in his mouth and spat it out again. The quantity of urine in those periods of 15 minutes was measured.

Fasting removed in all 6.5 ccms gastric juice HCl. 33 (39) A.49. Urine. Removed.

After 15 minutes/8 ccms. HCl 20(24). A.32 Urine 14 ccms.
« « « Removed 20.5 ccms. HCl 20(24) A.32 Urine. 15 ccms.

The concentration of alcohol in the urine was measured in both tests and was found to be 0.0015 %. In the last test, when he smelt and tasted the aquavit, at least 20 ccms of gastric juice were secreted, whilst in the check test 8 ccms were found. The secretion of gastric juice in this man also appears to have increased two and a half times with the sight, smell and taste of aquavit in the course of 15 minutes (a usual time for eating a Bourget meal). The gastric juice secreted in both cases has the same qualitative composition, and the figures for HCl and total acidity are equal in both cases.

Experiment 65.

Man. 25 years old. Has drunk a little beer and wine now and then, but often at intervals of weeks. Prior to the test he had not consumed alcohol for several days.

1. Removed fasting 11 ccms slimy. HCl 0(6). A.13.
2. After 15 minutes rest on couch 58 ccms. — HCl 17.5(21) A.28.5 $P_H = 1.85$.
3. After 15 minutes smelt a dram of aquavit & washed out his mouth 3 times with it, every 5 minutes. 51 ccms. HCl 25(29.5) A.34.5 $P_H = 1.66$. I 10 ccms. 18 mgrs alcohol.

In the second test, without any influence whatever by alcohol, 58 ccms of gastric juice were found to be secreted in 15 minutes. This gastric juice showed a free HCl of 17.5 and a $P_H = 1.85$ and also a digestive capacity corresponding to seven and a half hours i.e. 20 ccms gastric juice digested a cube of white of egg in the thermostat in seven and a half hours.

In the third test, under the influences of smell, sight and taste of aquavit, the amount of gastric juice was 51 ccms, i.e. slightly less than in the previous experiment. On the other hand there was more free HCl in the gastric juice.

The latter had free HCl = 25, P_H = 1.66 and the digestive capacity corresponded to five hours, i. e. 50 % better than in the first case.

It appeared that it had not been possible to avoid that in tasting and rinsing out his mouth with the aquavit, a very small quantity found its way into the stomach. For the gastric juice in the last test exhibits a concentration of alcohol of 0.22 % (vol %) whilst in the first case there was found a normal concentration of alcohol of 0.0015 %. For this reason the experiment is unreliable.

However, it is improbable that this tiny dose of alcohol alone could increase the free HCl to such a degree. The increase if not accidental must therefore be attributed to a direct psychic influence. (After remaining in the thermostat, in the digestion test, the second specimen showed HCl 9. 5 (13.5). A.26 and the third specimen HCl 22 (25) A.35. A slight quantity of the free HCl has thus disappeared during digestion, mainly bound to the albumen).

Experiment 66.

Man. 27 years old, weight 73 kilos. Earlier in the year had slight dyspepsia, but at time of experiment quite well.

1. Recovered fasting.	35 ccms. A.26.	colourless Conc.	HCl 0(0). of Alc. 0.0096 %	
2. After resting on couch 15 mins.	19 ccms.	HCl 0(0).	A.12	
3. » » » sight of one glass aquavit	20 »	HCl 0(0).	A.11.	
4. » » » rinsing mouth 3 times	9 »	HCl 14(16)	A.34.	
5. After 15 minutes smelling NH_3	2 »	HCl 0.		

An ordinary Ewald test carried out earlier gave: Recovered 140 ccms. HCl 35. A.73. Sight of aquavit alone appears to had no influence whatever upon the secretion of gastric juice.

The gastric juice was fairly alike in tests 2 and 3, both qualitatively and quantitatively.

The alcohol was placed in a small (dram) glass on an uncovered table, i. e. not served in a very appetizing way. According to the investigations of *Miller and others,* (114) the appetizing serving of food is an important factor in the production of psychic secretion through sight. But it cannot be of great importance to make the experiment in such a way that a dram is placed amongst attractive food on a well decked table, for in that case it is impossible to decide whether it is the sight of the food or the sight of the dram or it may be both which occasion an increase in the secretion of gastric juice.

The *taste* and *smell* of aquavit appear to have influenced the secretion of gastric juice, for the latter is reduced in quantity, but somewhat improved in quality. For whilst in the first tests there is no demonstrable free or bound HCl, in the fourth test they are present in comparatively considerable quantities. It can scarcely be regarded as due to the saliva swallowed in the first tests that these are larger. In that case it should have been possible to demonstrate at least some bound HCl, if not free HCl in these specimens.

At the same time we see in this experiment that the smell of such an irritating and unpleasant liquid as *ammonia,* reduced the secretion of gastric juice.

Experiment 67.

Man. 49 years old. Until he was 25 years of age had drunk a great deal of beer, wine and spirits, but after that was teetotaller.

1.	From fasting stomach recovered 71 ccms. Slightly gall coloured.	HCl 34(38). A.50.
2.	After 15 minutes resting on couch, 24 ccms. almost colourless.	HCl 18(22). A.30.
3.	After 15 minutes rinsed mouth and smelt aquavit colourless 13 ccms.	HCl 25(27.5). A.43.
4.	After 15 mins., smelt. NH_3 8 c.cms.	HCl 25(28). A.46.
5.	After Ewald's test breakfast, recovered 100 c cms.	HCl 10(18). A.40.

In this experiment we find more gastric juice *without* the influence of the sight and taste of aquavit. The gastric juice obtained under the psychic influence of alcohol contains, however, more free HCl and has a correspondingly higher total acidity than that obtained without such influence.

By smelling *ammonia* a smell which was said to have an irritating and unpleasant effect upon him, the secretion of gastric juice was further restricted.

Experiment 68.

Man, 34 years old, 80 kilos in weight, healthy but slightly neurotic. Is in the habit of drinking half a bottle of Bayer beer (lager) with his meals. When he does not take beer with his food, it seem to him he cannot digest it properly.

1.	Recovered from fasting stomach	11	ccms.	HCl	32(35)	A.44.
2.	After 15 mins. rest on couch,	35	»	»	4(5)	» 13.
3.	After 15 mins. rinsing mouth with beer	10	»	»	17(20)	» 33.
4.	After 15 mins. rinsing mouth with aquavit	8	»	»	17(20)	» 36,5.

Part of the increased secretion of gastric juice in second test is doubtless due to the saliva swallowed. For during the experiment the patient lay, and had repeated swallowing movements. If we reckon that without admixture of saliva there would be secreted 10 ccms. of gastric juice (as in the other tests) the figures for acid would have shown 3.5 x. 4(5). 13 = HCl 14 (17.5) A.45. and we approach fairly near to the figures found for gastric juice in tests 3 and 4. The slight difference could in that case be attributed to the influence to the saliva upon the gastric juice? In the case in question it was found difficult to prevent the patient, nervous as he was, from swallowing some saliva on account of the irritation of the tube in his mouth. This swallowing is of course entirely avoided by rinsing the mouth with beer or spirits. It is scarcely reasonable to assume that the patient swallowed as much as 25 ccms. This experiment, therefore, although doubtful, may be said to indicate that the smell and taste of beer and aquavit increased the quantity of HCl but not the secretion.

Experiment 69.

Man, 26 years old, weight 60 kilos, healthy. Is in the habit of drinking half a bottle of Bayer beer with his dinner.

1.	Recovered from fasting stomach	29 ccms.	HCl 20(22)	A.33.
2.	After 15 mins. resting on couch	16 »	» 22(25)	» 38.
3.	» 15 » rinsing mouth repeatedly with Pilsener beer	6 »	» 26(30)	» 40.

In this case the smell and taste of beer did not increase the secretion of gastric juice. However, the secreted gastric juice had a larger amount of HCl and a higher total acidity.

Experiment 70.

After emptying his stomach, the following experiment was made with the same man.

He drank 300 ccms. of Pilsener beer (3.6 % alcohol). Thus he received in all 8.7 grms. of alcohol and 15 mins. after all the contents of the stomach were removed, 205 ccms. in all. The degree of alcohol in these contents was 0.85 weight % (1.07 vol. %), i. e. in all 1.74 grms alcohol. A determination of the degree of acid gave HCl 8(12) A.40. Thus in the course of 15 minutes 80 % of the alcohol in the beer had already disappeared and presumably been resorbed. This shows how extremely quickly alcohol is resorbed from the stomach. If we compare this with experiment 3, in which the patient besides drinking beer also ate a Bourget meal, we see how very much more quickly alcohol is resorbed on an emply stomach than on a full one.

As discussed on page 104, the beer binds the free HCl. Thus 300 ccms. of beer bind 30 ccms. o.l n.HCl.

If nevertheless, after drinking 300 ccms. of Pilsener beer, the contents of the stomach show HCl = 8, this means that in those 15 minutes there must have been produced a quantity of gastric juice equalling about 175 ccms. As stated previously the calculation must only be regarded as approximately correct. Thus in the 15 minutes (experiment 1) there enter the stomach 300 ccms. of beer and about 175 ccms. of gastric juice, in all 475 ccms, whilst as mentioned 205 ccms. were removed. We see from this experiment how much more vigorously the secretion of gastric juice takes place, when in addition to seeing, smelling and tasting the patient also *swallows* the beer. As we see, there is resorbed in 15 minutes so much of the alcohol that its secretion promoting power comes into effect. We must not overlook the circumstance that the increased secretion is also due to the secretion promoting substances in the beer (extracts).

Table showing general results.

(«psychic» secretion).

No.	*Without influences.*			*Influence of sight, smell & taste.*		
	Recovered.	*HCl*	*A.*	*Recovered.*	*HCl*	*A.*
1.	8	20	32	20.5	20	32
2.	58	17.5	28.5	51	25	34.5
3.	19	0	12	9	14	35
4.	24	18	30	13	25	43
5.	35	4	13	10	17	33
6.	16	22	38	6	26	40

As regards the «psychic» effects of alcohol upon the amount of secretion, it will be seen from the table that in only one case is there an increase. In the other 5 cases there is a diminished amount of secretion in the experiments with alcohol, and in 4 of them (3, 4, 5 & 6) there is actually only one half of the quantity in the check experiment.

By comparing the free HCl and total acidity, however, it will be seen that in the 5 cases mentioned above, in which there is diminished secretion, there is an increased amount of free HCl and total acidity.

In one case (1) where there is an increase in the quantity of secretion in the experiment with alcohol, there is no difference between the free HCl and the total acidity.

It would appear from these experiments that the secretion of gastric juice in the conditions of experiment here employed is not appreciably effected by the sight, smell or tasting of alcohol (spirits or beer). On the other hand it seems that the gastric juice secreted contains more free HCl and has a greater total acidity.

Thus even though the importance of alcoholic drinks for the promotion of the «psychic» secretion of gastric juice must be said to be comparatively small and extremely variable, yet it may exercise influence.

The secretion of gastric juice in a period of 15 minutes (the time taken to eat an ordinary meal) amounts in these experiments to between 8 and 59 ccms., on an average 25 ccms. In the experiments with alcohol we found on an average 20 ccms.

In earlier experiments (1 and 4) the amount of secretion of gastric juice in a Bourget meal was estimatad at 190 ccms. and 180 ccms. respectively, and in experiment 70 at 175 ccms. in 15 minutes. If any importance can be attached to these calculations, it would appear that the quantity of gastric juice obtained in the course of 15 minutes without influence amounts to not more than 10 % (and at the most 25 %) of the quantity of gastric juice obtained when in addition to seeing, smelling and tasting alcohol and food, the food is *chewed* and *swallowed* with the alcohol into the stomach.

For in general it should be remembered that the «psychic» influence must vary, being dependent upon various individual circumstances, particularly upon the state of mind of the individual at the moment, but in addition the «liking» for alcohol of the individual, his habituation, etc., naturally play their part. For of course there are many persons, especially women, who think the taste of alcohol (spirits) unpleasant.

VI. The Influence of Alcohol upon the Motor Functions of the Stomach.

As regards the effects of alcohol upon the motor functions of the stomach, we find very scanty information in medical literature. As far as I have been able to ascertain the only investigations which directly concerned themselves with this question are those of Crämer (35), who examined a person stated to be healthy, who regulary drank $1/2$ litre of beer with his dinner. If instead he was given 1 litre, motor insufficiency was proved. A similar motor insufficiency was found in experiments with non- alcoholic wines. Crämer therefore considers that in this matter alcohol does not play any part. As he himself says, one experiment does not lend itself to the drawing of a conclusion.

The following series of experiments were carried out with the object of investigating the effects of alcohol upon the *motor functions* of the stomach. At the same time there were included the resorption and secretion conditions of alcohol. The test meals employed had about the same composition as a Bourget-Faber meal and consisted of:

Test Meal I. A plate of oatmeal gruel (as before) 100 ccms. of beef tea (Bouillon). 60 grms of veal. 60 grms wheaten bread. 2 tablespoons full of preserved cranberries.

Test Meal II. As above + 15 ccms. of aquavit. With regard to the general method employed, reference is made to the account given on page 5. It should be noted, however, that each meal is exactly weighed.

As these experiments were carried out with patients suffering from various digestive troubles, a short history of the case is given.

The patients were not informed beforehand that they were given alcohol with their food. Those who did not know the taste thought therefore that it was medicine.

Experiment 71.

Man, 39 years of age, has had digestive troubles for about 15 years, with sour belching and sluggish motions. Hematemesis 3 years before. Has pain at beginning of meals and during the night. Diagnosis: ulcus duodeni. (Also Röntgen diagnosis).

Recovered, fasting	40 ccms.	HCl	78.	A.95.
After Ewald's test breakfast	30 »	»	76.	» 98.

Test Meal I. After 3 hours: Directly recovered 65 ccms, of which 20 ccms. precipitate. HCl 98. A.123. Washed with 1 litre water, no precipitate.

Test Meal II. Directly recovered 40 ccms. of which 10 ccms. precipitate. HCl 103. A.131. Pep. capacity in both tests 99 %.

We see that in test meal II (with alcohol) there was less left in the stomach after the course of 3 hours than in test meal I, i. e. 40 and 65 ccms. respectively, with precipitate after washing, 10 and 20 respectively

Experiment 72.

Woman, 63 years old, has had dyspepsia for several years. Feels enervated and tired, but looks quite healthy. She has vague pains in her abdomen after a meal. A Röntgen photograph shows gastroptosis with curv. maj. a hand's breadth below umbilicus. Diagnosis: Gastroptosis with some retention.

Test Meal I. Recovered direct 65 ccms. of which 35 ccms. precipitate HCl 37. A.58. Washed with 1 litre water, no precipitate.

Test Meal II. Recovered direct 95 ccms., of which 55 ccms. precipitate. HCl 38. A.58. Washed with 1 litre water no precipitate.

In this case the alcohol so far from promoting motor functions *appears on the contrary to have delayed them.*

Experiment 73.

Man, 58 years of age. Was ill a little more than 1 month before, with lassitude and dyspepsia. After Ewald's test breakfast, 90 ccms. recovered, with HCl 0. A.5. Uff. doubtful. Röntgen examination appears to indicate tumor ventriculi (cancer?) with constriction of the stomach, (hour-glass stomach). Weber's test on motions was weak + Diagnosis: Cancer ventriculi?

Test Meal I. Nothing direct, but on lavage with 1 litre of water recovered large lumps of mucus and undigested remnants of food, especially large quantities of crust of bread. HCl O. Congo —

Test Meal II. Nothing direct. After lavage with 1 litre of water there came, as compared with test I, only inconsiderable remnants of food. In order to be certain (of hour-glass stomach) afterwards washed with 1 ½ litres of water, when only two or three lumps were obtained. HCl O. Congo —.

Experiment 74.

Man, 21 years old, only exhibited symptons of nervous dyspepsia and hyperchlorhydria. This is the man who was also used for experiment 47.

Test Meal I. Recovered direct 55 cms. of which 8 ccms. precipitate. HCl 88, A.117. Washed with 1 litre of water. Small precipitate merely consisting of a few fine flakes. Pep = 82 %.

Test Meal II. Recovered direct 50 ccms., of which 7 ccms. precipitate, HCl 71. A.99. Washed with 1 litre of water; only a few flakes settle on the bottom. Pep = 94 %.

These two experiments give approximately the same result. In the first test the amount of free HCl is abnormally large, whilst in the second test it is not fully so high

Experiment 75.

Man, 57 years of age, has had dyspepsia for several years with vomiting and pain. Both clinical and röntgenological diagnosis are: — ulcus ventriculi c. gastroptosis. Curv. maj. lies about 1 ½ handsbreath below the umbilical transversal, and retention is present.

Test Meal I. Recovered direct 200 ccms. of which 150 ccms. precipitate. Washed with one litre of water. Nothing left.

Test Meal II. Recovered direct 250 ccms. of which 130 ccms. precipitate. HCl 25. A.105. Washing as above. In addition with both tests there were 30 to 40 ccms. floating at the top of the precipitate tubes, mainly cranberry seeds.

In this man, with symptoms of gastroptosis and retention, the alcohol did not bring about any marked alterations.

Experiment 76.

Man. 55 years of age For a considerable time has had periodically slight ructus and pyrosis. During these periods he has pain just after meals. Diagnosis Ulcus? with hyper-secretion. Röntgen diagnosis: Hyper-peristaltic, hyper-secretion. Stomach emptied in the morning fasting, and 65 ccms. clear colourless liquid obtained HCl 38. A.54. After Ewald. Recovered 225 ccms. HCl 43 A.68. Before the alcohol experiments a number of investigations were made as to the motor functions of the stomach.

1. Bourget after 5 hours. Recovered direct 10 c.cms. Rinsing water, medium precipitate.
2. Bourget after 7 hours. Recovered 25 ccms — almost clear.
3. Bourget after 8 hours. Recovered 25 ccms. — some cranberry seeds.
4. Bourget after 10 hours. Recovered 25 ccms. Clear.

Patient was examined there times, with 8 day's interval in order to find out the amount of the contents of his stomach in the morning when fasting.

1.	115 ccms.	HCl 51.	A.62
2.	50 »	» 45.	A.67
3.	60 »	» 58.	A.71

Test Meal I. Recovered direct 100 ccms. of which 15 ccms. precipitate. HCl 75. A.89. Rinsing water clear.

Test Meal II. Recovered direct 160 ccms. of which 15 ccms precipitate. HCl 71. A.87. Rinsing water clear.

As in experiment 75, there is here an increase in the quantity of liquid in the stomach after three hours by the addition of alcohol. In spite of this the contents of acid are almost the same in both tests. As the contents of the stomach increased by 60 % this might of course indicate that alcohol prevented the evacuation of the contents of the stomach and thus brought about the increased contents of the stomach in test II. We see however, that the permanent filtrate in both tests is equally large. The increased amount of liquid must therefore be due to increased secretion. It appears from the Bourget test meals given earlier that the amount of liquid in the stomach on various days and after various intervals of time remains fairly constant, and that there is no retention, but on the contrary hyper-secretion. The same conditions are present as regards the HCl and total acidity. The figures for these also remain fairly constant.

Experiment 77.

Man. 27 years old, the same patient as in experiment 48. Prior to the experiment there were removed from the patient's stomach, fasting, 275 ccms, greyish black liquid, of which 50 ccms. precipitate, HCl 70, A.90. Slime. +

Test Meal I. Recovered direct 790 ccms of which 325 ccms precipitate. HCl 84. A.130. Before the next experiment there were likewise removed from the stomach, fasting, 225 ccms of greyish green liquid, of which 55 ccms precipitate Slime, + HCl. 70. A.90.

Test Meal II. Recovered direct 750 ccms of which 245 precipitate. Washed with one litre water, whereupon 5 ccms precipitate. HCl 75. A.116. Slime. +

We have before us a man with a very poor digestion, where alcohol in the form of a single dram appears to promote motor activity. In the first test we have an amount of liquid equal to 790 ccms and a precipitate equal to 325 ccms. i. e. practically all the test meal returns unaltered after three hours, whilst in the second test some part must have passed pylorus for we find in it 245 ccms of precipitate. We now have, in spite of a smaller quantity of liquid (750) a total precipitate of 250, whilst with the first experiment we had a total precipitate of 325. This condition indicates a more rapid evacuation of the stomach in test II. However, the experiment should be taken with reservation on account of the far advanced dilatation of the stomach.

Experiment 78.

Woman 40 years old, previously operated for cancer of the uterus. Has now pains in stomach and back and feels weak. Has difficulty in tolerating her food and is troubled with vomiting. At night her mouth fills with water. Diagnosis: Achylia gastrica.

Test Meal I. Recovered direct 25 ccms, mainly cranberries. HCl O. A.48. Uff. —. Mucus +. Rinsed with one litre water and the rinsing water (850 ccms.) contained no less than 110 ccms. of precipitate.

Test Meal II. Recovered direct 50 ccms of cranberries and a little mucus. HCl 0. A.44. In the rinsing water (875 ccms) there were then only 10 ccms of precipitate.

With this patient there was comparatively little mucus in the contents of the stomach. Whilst in the first test there was a considerable amount of precipitate, over 100 ccms, in the second test there was practically nothing left in the stomach, only 10 ccms being precipitated in the rinsing water. There appears to have been a more rapid evacuation in the experiment with alcohol.

Experiment 79.

Man. 43 years, during recent years has suffered from chronic enteritis and dyspepsia. Feels poorly after food and is languid and tired. At one time drank a great deal of alcohol, but is now stated to be very sober.

Test Meal I. Recovered direct 60 ccms of which 30 ccms precipitate, HCl 17. A.68 Mucus, Sanguis + In addition vomited 200 ccms with 15 ccms precipitate and 35 ccms in the rinsing water.

Test Meal II. Recovered direct 65 ccms, of which 35 ccms precipitate. HCl 26. A 98. Mucus + and Sanguis +, 35 ccms in the rinsing water.

In the alcohol test there were in all 70 ccms of precipitate, whilst there were 80 ccms in the first test. In the second test both the free HCl and the total acidity were higher than in the first test.

Experiment 80.

Man, 49 years old. Suffering from cancer ventriculi. Violent diarrhoea, and has become emaciated during the last six months. Appetite poor.

Test Meal I. Recovered direct 25 ccms yellowish green contents of stomach with only 2 or 3 cranberry seeds. After washing with 1 litre of water there was only a small flaked precipitate which could not be measured. HCl 0. A 10.

Test Meal II. Recovered direct 45 ccms of which 20 ccms precipitate. HCl 0. A 38. Rinsed with 1 litre of water, about 20 ccms precipitate Uff +.

In this cancer patient, whose strength was considerably reduced, alcohol had no effect. On subsequent rinsings the contents of the stomach proved to be slightly different, retention varying each morning according to what the patient had eaten the day before.

Experiment 81.

Man, 20 years of age, suffering from dyspepsia achlorhydria. Appendectomy two years before. Poor appetite subsequently. Drinks scarcely any alcohol.

Test Meal I. Recovered direct 18 ccms, of which 10 ccms precipitate. HCl 0. A 53. After rinsing with 1 litre water, 30 ccms precipitate found.

Test Meal II. (With 30 grms aquavit). Recovered direct 70 ccms, of which 60 ccms precipitate. HCl 10. A. 75. After rinsing 45 ccms precipitate.

With this patient there were made 6 determinations in all of the composition of the gastric contents after test breakfasts and test dinners (3 of each, without alcohol). In none of these tests was there proved to be free HCl. It is therefore noteworthy that in the second test (with 30 grms. of aquavit) the HCl was 10. In the experiment with alcohol there was found a considerably larger precipitate than in the experiment without alcohol.

One month later a new test was made with 30 grms. of aquavit with the food, but on this occasion no HCl was found. In this last test the patient was only given an ordinary Ewald test Breakfast.

Experiment 82.

Man, 52 years old, suffering from cancer ventriculi. In addition he has had enteritis for several months and is greatly emaciated and cachectic.

Test Meal I. Removed direct 25 ccms, of which 15 ccms precipitate. Sanguis + HCl 0. A. 4. There were 5 ccms of precipitate in the rinsing water.

Test Meal II. Recovered direct 50 ccms of which 10 ccms precipitate. Sanguis + HCl 0. A 16. After rinsing 10 ccms precipitate. Uff. markedly +.

No essential difference between the two tests with this patient. As the gastric contents were sanguinolent, we cannot attribute very great importance to the chemical investigations.

Table giving general results (Motor function of the stomach).

	Without alcohol			*With alcohol*		
No.	Precipitate	HCl	A.	Precipitate	HCl	A.
1.	20	98	123	10	103	131
2.	35	37	58	55	38	58
3.	+	0		—	0	
4.	8	88	117	7	71	99
5.	15	75	89	15	71	87
6.	325	84	130	245	75	116
7.	135	0	48	60	0	44
8.	80	17	68	70	26	98
9.	0	0	10	20	0	38
10.	40	0	53	105	10	75
11.	15	0	4	20	0	16
12.	150	25	98	130	25	101

In six cases (1, 3, 6, 7, 8 & 12), i.e. in one half of the tests recorded above, there was found a reduced quantity of precipitate in the experiments with alcohol as compared with those without alcohol. This would appear to indicate that in these cases there has been a more rapid emptying of the stomach on account of the effects of the alcohol. In two cases (4 & 5) there is no change, whilst in 4 cases (2, 9, 10 & 11) an increased quantity of precipitate was found. Thus in these 4 cases the alcohol has not had the effect of promoting the motor function. Indeed the opposite is the case. Of these 4 cases, 2 were cases of cancer ventriculi, 1 of achylia and 1 of gastroptosis with retention. In test No. 10 (the case of achylia) there was no free HCl in the first meal but on the contrary there was some in the »alcohol« meal. In spite of this the motor function was not more rapid in the latter case. Even though these experiments on patients cannot entirely be compared with experiments upon healthy persons, they nevertheless appear to show that alcohol, at least in these slight strengths, has not a constant effect upon the motor functions. In cancer patients the alcohol does not appear to have promoted the motor function, rather the reverse, whilst in the various patients suffering from dyspepsia it appears to have promoted the motor function. We likewise see that alcohol in the case of certain patients suffering from achylia appears to be of use (CP. 78 test No. 7).

With regard to the relation of alcohol to the free HCl and the total acidity in these experiments, in 3 cases (1, 8 & 10) there was an increase, and in 3 cases a diminution (4, 5 & 6), whilst in the other cases there was no change.

VII. Experiments with Wine and Beer.

Medical literature contains a number of experiments concerning the effects upon digestion of various kinds of beer and wine. *Buchner* (19) carried out a number of experiments with mixtures of beer and wine and solution of pepsin in vitro. He finds that both beer and wine hinder proteolysis. This seemed to him all the more striking because a mixture of pure alcohol of the same strength as the kinds of beer and wine used, had no retarding effect upon proteolysis. Thus the retardation could not be due to the alcohol in beer and wine but to other constituents of those liquids. He endeavoured to find out what were the constituents in question and finally he decided upon the salts contained in beer and wine. He believed he could prove that it was the combination of these salts with the HCl which resulted in pepsin digestion proceeding more slowly when beer and wine are added.

Crämer (35) made similar experiments in vitro, and is surprised to find that wine and beer hinder digestion. He made check experiments with non-alcoholic wines and found that these hindered digestion to a corresponding degree, and he considered, like Buchner, that it could not be the alcohol in beer and wine which disturbed digestion. *Chittenden* came to the same result by his researches, as did also Chase (34).

All these investigators are of the opinion that there must be various faults in their methods of research, and they therefore consider that this problem cannot be solved by laboratory experiments alone.

We shall here first of all give an account of two experiments with natural gastric juice, which in a highly satisfactory manner show the same conditions as those found by the above-mentioned investigators, viz. *that wine has a retarding effect upon proteolysis in vitro*. If we compare these experiments with the corresponding ones with pure alcohol mentioned above, it will be seen that it cannot be the amount of alcohol in the wine that is the cause of this retardation.

Experiment 83.

Experiment with Rhenish wine (percentage of alcohol 10.7). The gastric contents employed was taken from a man 31 years of age. It contained HCl 14(16). A 48. Günzburg 14 $P_H = 1.9$. The specimens were placed in the thermostat at 38° for 6 hours, and constantly stirred, 9 times round per minute.

	Gastric Juice in ccms.	Albumen in grms.	Water in ccms.	Rhenish Wine in ccms.	Alcohol in %	P_H	A.	Undissolved egg. in grms.
1.	10	0.06	20	0	0	2.3	16	0.002
2.	«	«	18	2	0.71	2.9	21	0.005
3.	«	«	15	5	1.8	3.2	29	lacking
4.	«	«	10	10	3.6	3.3	47	0.030
5.	«	«		20	7.1	3.5	79	0.045
6.		«	30 (check)		0			0.062

Experiment 84.

With claret (9 74 % alcohol). Same gastric contents as in previous experiment. Kept in thermostat at 38° for 5 hours.

	Gastric Juice in ccms.	Albumen in grms.	Water in ccms.	Rhenish Wine in ccms.	Alcohol in %	HCl	A.	P_H	Undissolved egg. in grms.
1.	10	0.06	20	0	0	4	16	2.3	0.004
2.	«	«	18	2	0.65	0	21	2.9	0.0012
3.	«	«	15	5	1.62	0	28	3.0	0.0032
4.	«	«	10	10	3.25	0	54	3.2	0.045
5.	«	«	8	12	3.9	0	52	3.4	0.046
6.	«	«	4	16	5.1	0	59	3.69	0.042
7.	«	«	2	18	5.7	0	64	3.9	0.046
8.	«	«		20	6.5	0	68		0.046
9.	30	water + egg (check)							0.0575

If we consider these experiments, it is quite striking to observe how the pepsin proteolysis is disturbed by the addition of an increasing quantity of wine.

In the first experiment with *Rhenish wine* the proteolysis is hampered by such small quantities of wine that the quantity of alcohol according to the experiments with pure alcohol cannot be of importance. With, for instance a degree of alcohol of 3.6, the amount of albumen dissolved is only one half of that dissolved in the test without wine.

As regards claret, the solution with a degree of alcohol = 3.25 is reduced to less than one half of the original without wine. As we have already seen, a degree of pure alcohol of 3 % to 4 % causes no obstacle to the proteolysis. There must thus be other constituents than the alcohol in the wine which have a disturbing effect upon digestion.

The causes of this disturbance become evident when we review the determinations of free HCl and the hydrogen-ion-concentration. *The repression of the proteolysis must be attributed to the reduction of the hydrogen-ion-concentration which has been proved to take place* when wine is added to the gastric juice. The pepsin in the gastric juice, which as mentioned above normally acts with a $P_H = 1.2 - 1.5$, is hindered when P_H rises above 2, and even when $P_H = 3$ the proteolytic capacity of pepsin has almost entirely disappeared. As regards the contents of tartar, tartaric acid etc. in the varieties of wine used, see page 22.

The repressing influence on the urine in these experiments is undoubtedly mainly due to the reduction of the concentration of hydrogen-ions, the HCl entering into connection with the acid salts of the wine, expelling the weaker and less dissociated acids such as tartaric acid etc., and the result is that the comparatively small quantity of free HCl is bound and other acids released, the alkali salts with vinous acidity acting as »impulses «(puffer). This also appears from the experiment in which at the beginning we can prove the presence of the free HCl, which in the second experiment with e.g. claret is = 4, shown by using dimethylamidoazobenzol (and 2 by using Günzburg), whilst the total acidity is then only 16. In the next test there is no more free HCl demonstrable, whilst the bound HCl has increased like the total acidity. The latter increases quite steadily, and in the Rhenish wine experiment even becomes 79, in the claret experiment 68, an experiment for the acids and acid salts originating in the wine.

If for instance we take *Rhenish* wine, we find when we titrate 10 ccms of the wine that we must use 10.2 ccms 0.1 n NaOH and before it becomes neutral with phenolphtalein as indicator and 60 ccms when we use lacmoid as indicator. Thus the Rhenish wine has an »acidity degree« of 102 and 60 respectively. If we measure the concentration of hydrogen ions we find $P_H = 3.3$. If on the other hand we add 0.1 n HCl to 10 ccms Rhenish wine it will be found that as much as 4.3 ccms will be required before we can show the presence of free HCl (with Günzburg). Rhenish wine thus saturates so much HCl, i.e. the salts in the Rhenish wine combine with the HCl in the proportion 100 to 43. If we desire to reneutralize the liquid we need 9.00 ccms 0.1 n NaOH for the purpose. By adding 4.3 ccms 0.1 n HCl to 10 ccms of Rhenish wine the concentration of hydrogen-ions is changed from $P_H = 3.3$ to $P_H = 2.2$.

If we reckon that a normal gastric contents contain 0.15 % of HCl, 100 grms of gastric contents contain 0.15 grms HCl. Since 100 ccms of Rhenish wine are = 43 ccms 0.1 n HCl = 43 x. 0.00365 = 0.015695; this in other words means *that a normal gastric contents with a free HCl of 43 corresponding to an HCl % of 0.15 will be exactly neutralized by equal quantities of Rhenish wine.* Thus if we drink 100 ccms of Rhenish wine and have in the stomach 100 ccms of gastric contents of normal acidity, all the free HCl which is necessary for pepsin digestion is bound, and instead we obtain other and less dissociated acids and acid salts which cannot replace the free HCl, so that in consequence the pepsin proteolysis becomes quite considerable.

As regards *claret*, we find almost the same figures. These naturally vary according to the alkali salts of vinous acidity contained in the wine. Thus in the case of the claret employed (Chateau Beausite 1909) 3.3 ccms 0.1 n HCl had to be added to 10 ccms before free HCl could be shown (by Günzburg's reagent). The determination of the concentration of hydrogen-ions by colorimetric means is rendered difficult by the colour of the wine.

Somewhat more is also required of this claret to »neutralize« the same amount of gastric juice than in the case of the Rhenish wine. The proportion corresponds approximately to the total contents of tartar and tartaric acid of the two wines, this being 0.51 in the case of Rhenish wine and 0.38 for claret (see p. 19).

As regards *beer*, the proportion is about the same as for wine. It is also the contents of alkali salts of weak (organic) acids in the beer which determine the amount of HCl that can be bound. Three different samples of Frydenlund's pilsener beer, the alcoholic strength and contents of extracts of which have previously been quoted, showed the following proportion: —

10	ccms		»neutralized«	1	ccms	0.1 n	HCl
100	«		«	10	«	« «	«
300	«	1/2 bottle	«	35	«	« «	«

After this there can be no doubt that both beer and wine to an appreciable extent reduce the amount of free HCl in vitro in the gastric juice, but it is not thereby certain that they also produce an actual reduction in natural conditions.

The following experiments therefore deal with the effects of beer and wine upon digestion in a number of healthy individuals of various ages and sex.

For these experiments there were chosen a number of persons who had not previously drunk beer or wine. Regarding the composition of the test meals, and the quantity of beer and wine, see page 3 of »Methods«. Ewald's test breakfast is shortened to »Ewald« and Bourget's dinner to »Bourget«.

Experiment 85 (with »Landsøl« = a very light lager).

Man, stated to be healthy, 36 years old. Experiment with *Landsøl*.

1st day: Recovered from fasting stomach 10 ccms. Congo —. After Ewald's test breakfast recovered 180 ccms HCl 0. A 7. $P_H = 4.0$.

Bourget: (After 3 hours). Recovered direct 27 ccms in form of thick precipitate. After lavage with 1 litre water recovered 980 ccms, in which 2 ccms precipitate, i.e. in all 29 ccms of precipitate. Unfiltered it showed HCl 0. A 47.

Urine test:	After 1	hours	140	ccms.
	« 2	«	240	«
	« 3	«	85	«
			465	

2nd day: *Bourget* (with 225 ccms landsøl). After 3 hours recovered 6 ccms. Lavage with 1 litre water. Recovered 900 ccms precipitating 3 ccms, i.e. in all 6 ccms. There was too little to determine the acidity of the gastric contents.

Urine test:	After 1	hour	25	ccms	alcohol	0.4 grms	= 0.001 g.
	« 2	«	35	«	«	0.7 «	= 0.00245 «
	« 3	«	34	«	«	0.2 «	= 0.00068 «
			94	ccms.			0.00413 g

The alleged healthy man was suffering, strangely enough, from achylia with poor gastric digestion. After 3 hours, however, most of the food had left the stomach in spite of the lacking free HCl which was not to be found either after 1 hour (Ewald) or 3 hours (Bourget). The determination of the remainder in the first experiment shows 29 ccms precipitate, whilst the remainder in the 2nd experiment with landsøl was 9 ccms. There thus appears to be a much more rapid evacuation of the stomach in the landsøl meal as compared with the test meal.

The amount of alcohol in the urine is small. There was secreted in all 0.00413 grms in the urine in the course of 3 hours, i. e. about 0.1 % of the total amount of alcohol in half a bottle of landsøl.

Experiment 86. (with Pilsener beer)

Woman, 25 years, healthy.

1st day: *Ewald:* Removed from fasting stomach 20 ccms. HCl 0. After breakfast removed 130 ccms. HCl 10. A.31. $P_H = 2.27$.

Bourget: Removed direct 50 ccms. Lavage with 1 litre water and removed 880 ccms., of which 30 ccms. precipitate. HCl 28 (37) A.69. $P_H = 1.6$.

Urine test:	After	1	hour	37	ccms.
	»	2	»	33	»
	»	3	»	34	»
				104	»

2nd day. *Bourget:* (225 ccms. Pilsener beer). Removed direct 100 ccms. After lavage with 1 litre water removed 800 ccms., of which 4 ccms. precipitate. HCl 32 (39) A.72. $P_H = 1.6$. In the 100 ccms. removed direct there was made a determination of alcohol. In one test, (10 ccms.) were found 4.9 mgrms of alcohol, and in the second 5.0 mgrms. After the lapse of 3 hours there was thus in the stomach a contents of alcohol of about 0.07 volume %.

Urine test:

												grms.
In	1	hour	43	ccms.	Alc. in	10	ccms.	1.48	mgr.	in	all	0.00799
»	2	»	59	»	»	»	»	0.55	»	»	»	0.00325
»	3	»	42	»	»	»	»	0.35	»	»	»	0.00147
			155									0.01271

The meal with Pilsener beer as compared with the test meal shows a slight increase in the free HCl in favour of beer. This however is so small that it is not evident in the determination of the concentration of hydrogen-ions, which was 1.6 in both experiments. The motor functions of the stomach appear fairly similar in both meals. The amount of alcohol secreted in the urine is also in this case only about 0.1 % of the quantity consumed.

Experiment 87.

Woman 39 years healthy.

1st day. *Ewald:* Removed 125 ccms. HCl 31. A.69. P_H = 1.6. The quantity of alcohol in the gastric contents, on account of the alcohol in the bread was found to be 0.017 %.

Bourget; Removed direct 26 ccms. After lavage with 1 litre of water recovered 900 ccms. from which 42 ccms. precipitate. HCl. 17 (23) A.50. P_H = 1.96. Degree of alcohol 0.8 mgms. in 10 ccms, i. e. 0.01 vol. %.

Urine test:	1 hour	14 ccms.
	2 »	7 »
	3 »	19 »
		40 »

2nd day: *Bourget.* (with 100 ccms. claret). Removed direct 74 ccms. In rinsing water (980 ccms.) there were 90 ccms. precipitate HCl 39 (54). A.83. P_H = 1.36. Degree of alcohol in 10 ccms. 8.58 mgs. Thus the gastric juice contains 0.11 vol. % of alcohol after 3 hours.

Urine test:	1 hour	24 ccms.	Alc. 1.6 mgs.	=	0.00384 gms.
	2 »	25 »	» 0.3 »	=	0.00075 »
	3 »	23 »	» 0.15 »	=	0.00035 »
		72		=	0.00494 »

Only 0.07 % of the amount of alcohol was secreted in the urine.

If we compare these 2 experiments (with and without claret) we see that the claret appears to have hampered digestion to some degree at first. Even after 3 hours the digestion has not advanced as far in the claret experiment as in the check meal, but on the other hand the contents of free HCl at that time are considerably higher in the «claret» meal. It has risen to more than double and at the same time the coefficient of hydrogen-ions has fallen from $P_H = 1.69$ to $P_H = 1.36$ i. e. the concentration of hydrogen has increased from $0.2 \times 10^{\div 1}$ to $0{,}45 \times 10^{\div 1}$ Gastric juice of such a character naturally exhibits a greater digestive capacity. With the first gastric contents the cubes of albumen were digested after $5^1/_2$ hours, whilst an equally large cube (0.06 grm.) was completely digested after 4 hours in a sample of gastric contents from the «claret» meal.

From this it appears that claret at first hampers gastric digestion because it binds some of the free HCl of the gastric juice and thereby reduces the concentration of hydrogen-ions. But little by little, after nearly all the alcohol in the claret is resorbed, the secretion of gastric juice increases. In spite of this the repression caused by the claret has not ceased (after 3 hours).

Experiment 88. (with claret).

Woman, healthy, 31 years of age.

1st day. *Ewald.* Fasting, before breakfast 10 ccms. After breakfast removed 130 ccms. HCl 25 (33) A.61. $P_H =$ 1.75.

Bourget: Removed direct 5 ccms. After lavage 20 ccms. precipitate. Some mucus; on account of the small quantity it was not possible to make a determination of the HCl and total acidity.

Urine test:	1 hour	248	ccms.
	2 »	55	»
	3 »	35	»
		338	

2nd day. *Bourget:* (with claret) Removed 8 ccms. In rinsing water (850 ccms.) there were 14 ccms. precipitate Quantity of alcohol in 10 ccms. 13 mgm, i. e. about 0.15 vol. %. HCl 28 (36). A.65. Mucus.

Urine test:

1	hrs.	190	ccms.	alc.	in	10	cms.	2.4 mgm.	in	all	0.0456	grms.
2	»	69	»	»	»	10	»	1.8 mgs.	»	»	0.0124	»
3	»	35	»	»	»	10	»	1.6 »	»	»	0.0085	»
		312	»								0.0665	»

Thus there was secreted in the urine about 0.1 % of the quantity of alcohol in the claret. In the first test after Bourget's meal, practically all the contents of the stomach must already have passed pylorus. We see, however, that evacuation of the ventriculi in both experiments took place almost equally quickly. If at first the digestion was less satisfactory in the «claret» meal, the delay at that stage had already been removed by the secretion promoting action of the claret.

Experiment 89 (with claret).

Women 35 years. Healthy.

First day. Ewald: Removed 65 ccms. HCl 23. (27) A.54 $P_H = 1.85$. A second test after Ewald's test breakfast had previously shown HCl 23(28 A.54 $P_H = 1.85$.

Bourget. Removed direct 13 ccms. In rinsing water (900 ccms) there were 65 ccms precipitate. HCl 21(32). A.51

Urine test.	1 hour	30	ccms.
	2 hours	107	»
	3 »	43	»
		180	»

Second day. Bourget (with claret):

Removed direct 8 ccms. After lavage with one litre water removed 850 ccms. of which 55 ccms precipitate. HCl 30(45). A.80. Quantity of alcohol in 10 ccms. 10 mgrms i. e. about 0.11 volume % in the gastric juice after three hours.

Urine test.

1	hour	64	ccms.	alcohol	in	10	ccms.	2.0 mgrs	in	all	0.0128	grms.
2	»	189	»	»	»	10	»	1.2 »	»	»	0.0216	»
3	»	27	»	»	»	10	»	0.16 »	»	»	0.0004	»
		271	»								0.0348	»

Thus in these three hours 0.0348 grms were secreted in the urine. The diuresis is somewhat large in the «claret» meal.

The digestion of the Bourget meal in this case proceeded more rapidly in the experiment with claret, the stomach having emptied more quickly in that experiment. The gastric contents removed contain greater quantities of free HCl. In the last experiment this increase to HCl 30, whilst in the first experiment it was HCl 21. Unfortunately the material was too small for a further comparison of the peptic strength and of the concentration of hydrogen-ions.

Experiment 90. (100 ccms Rhenish wine).

Man. 22 years old, suffering from chronic gastritis.

First day. Ewald: Removed 100 ccms HCl 14. A.45. In 10 ccms of the material removed there were. 83 milligrammes alcohol. (Fresh bread).

Bourget: Removed direct 9 ccms. After lavage with one litre of water, removed 950 ccms. from which 18 ccms precipitate. There were 0.74 milligrammes of alcohol in 10 ccms. Mucus.

Urine test:	1	hour	32 ccms.
	2	»	34 »
	3	»	29 »
			95

Second Day. Bourget: (with 100 ccms Rhenish wine). Removed direct 15 ccms. Lavage with one litre of water, of which recovered 900 ccms, and from which 15 ccms. precipitate. The amount of alcohol in 10 ccms 4.4 mgrs i. e. about 0.06 vol. % HCl 8(10). A.60. Mucus.

Urine test:

1	hour	32	ccms	alc in	10 ccms	0.8	mgrm.	in all	0.00256	grs.
2	»	33	»	» »	10 »	0.56	»	» »	0.00158	»
3	»	32	»	» »	10 »	0.31	»	» »	0.00096	»
		97							0.00537	»

No noteworthy difference in the two tests.

Experiment 91 (with Rhenish wine)

Woman, 22 years old. Healthy.

First day. Ewald.: Removed 135 ccms. HCl 28(34) A.60 $P_H = 1.65$
Amount of alcohol 0.007 volume %.

Bourget. Removed direct 23 ccms, after lavage and removal of 950 ccms, obtained 1 ccms precipitate. Contents of alcohol 0,009 % HCl 22(38) A.64. Urine test 196 ccms. in three hours.

Second Day. Bourget: (With Rhenish wine). Removed direct 36 ccms. After lavage and removal of 900 ccms. there were 50 ccms precipitate. Amount of alcohol 0.10 vol.% HCl 37. (49) A.70.

Urine test.	1 hour	33 ccms.	Alcohol	3.0 mgrms.	
	2 »	27 »	»	3.1 »	
	3 »	94 »	»	not examined.	

We see here also how the Rhenish wine delayed the motor functions of the stomach. In the course of three hours the increased secretion occasioned by Rhenish wine has not been able to overcome the restraining effect upon digestion. But the gastric juice which patient has after the lapse of 3 hours, contains more free HCl than in the test meal. For it has risen to almost double, and by comparing the digestive powers of the two gastric contents it appeared that albumen was entirely digested in the course of 4 hours in the «Rhenish wine» gastric juice, whilst it was not entirely digested after 6 hours 45 minutes in the second gastric juice test.

Experiment 92. (with Rhenish Wine).

Man. 17 years old. healthy.

First Day. Ewald: Removed 160 ccms. HCl 23(27) A.50. $P_H = 1.69$.

Bourget: Removed direct 100 ccms. After lavage with one litre of water, removed one litre with 20 ccms precipitate. HCl 23(42). A.102. $P_H = 1.6$.

Urine test:	1	hour	42	ccms.
	2	»	23	»
	3	»	25	»
			90	»

Second Day. Bourget (with Rhenish wine): Removed direct 68 ccms After lavage with one litre water, removed 980 ccms. from which 25 ccms precipitate. HCl. 52(70) A.118 $P_H = 1.2$.

Concentration of alcohol after three hours 0.08 volume %.

Urine Test:	1	hour	25	ccms	Alc.	0.15	mgrms	= 0.00038	grs.
	2	»	28	»	»	1.65	»	= 0.00462	»
	3	»	35	»	»	0.16	»	= 0.00056	»
			88					0.00556	»

Here the Rhenish wine in the course of only three hours has brought about such a vigorous secretion of gastric juice that digestion is considerably farther advanced in the Rhenish wine meal. If we compare the two gastric contents we see that the free HCl is more than double as large in the Rhenish wine meal, and at the same time the co-efficient of hydrogen-ions has changed from $P_H = 1.6$ to $P_H = 1.2$, i. e. the concentration of hydrogen-ions has increased from $0.26 \times 10^{\div 1}$ to $0.65 \times 10^{\div 1}$. With such a concentration of hydrogen-ions as $P_H = 1.2$ we have the most vigorous digestion. This is seen from a digestion experiment in the thermostat. Two cubes of albumen (each 0.06 grams) were digested with an equal amount of gastric contents from the two Bourget meals. With the gastric contents from Bourget I the albumen cube was digested after seven hours. After digestion, these gastric contents showed HCl 24(43) A.106. With gastric juice from the Rhenish wine meal — Bourget II — the albumen was digested after four hours 15 minutes, and this gastric juice after digestion showed HCl 53(72). The cencntration of hydrogen-ions was 1.6 and 1.2 respectively.

Table showing general results.

(Beer and Wine).

No.	Preoipitate in ccms.	HCl	A.	Presipitate in ccms.	HCl	A.	Alcohol in vol. % after 3 hours
	Without Beer				*With Beer.*		
1.	29	0	47	9			
2.	80	28 (37)	60	104	32 (39)	72	00.7
	Without Claret				*With Claret.*		
3.	68	17 (23)	50	164	39 (54)	83	0.11
4.	25			22	28 (36)	65	0.15
5.	78	21 (32)	51	62	30 (45)	80	0.11
	Withot Rhenish Wine				*With Rhenish Wine.*		
6.	27			30	8 (10)	60	0.96
7.	24	22 (38)	64	36	37 (49)	70	0.10
8.	130	23 (42)	102	72	52 (70)	118	0.08

In experiment (1) with Landsøl we obtain 4.23 ccms. absolute alcohol, in the experiment with pilsener (2) 8.1 ccms. alcohol, in the experiment with claret (3, 4 and 5) 100 ccms. claret = 9.74 ccms alcohol, and in the Rhenish wine experiments (6, 7, and 8) we obtain 100 ccms Rhenish wine = 10.70 c cms. alcohol. The concentration of alcohol in the test meals was 1.7 — 3.2 — 3.9 and 4.3 % respectively. After three hours, the concentration of alcohol in the gastric contents, as appears from the table, was only about 0.1 %. Thus after the lapse of three hours there is only a very small quantity of alcohol left in the stomach. At the same moment there is a concentration of alcohol in the urine lying between about 0.002 and 0.016 %.

If we compare these parallel experiments it will be seen, that in those with beer there is in the first experiment a more rapid evacuation of the meal with beer as compared with the check meal without beer, whilst the reverse is the case in the second experiment.

As regards claret, it will be seen from the first case (3) that there is a retarded evacuation in the claret meal, whilst in two other cases (4 and 5) ,there appears to be a more rapid motor function. As regards the Rhenish wine, there appears to be a retarded evacuation in two cases (6 and 7) whilst in one case (8) there is a more rapid evacuation of the gastric contents in the meal with Rhenish wine as compared with the meal without Rhenish wine.

Furthermore, if we compare the values found for the free HCl, the bound HCl and the total acidity, it will be seen that in the experiments where the investigations necessary for a comparison were carried out, there is in all cases an increase in the free and bound HCl and total acidity in the meals with beer and wine. In the experiment where no complete determination was made, the material was too small for the investigations. It is noteworthy to see how the *more nourishing* meals (e. g. the Bourget meal) show a larger contents of HCl and total acidity than the specimens from *less nourishing* meals (an ordinary Ewald breakfast). Of course the increase in the free HCl etc. in the Bourget meal also results from the longer time that the food has been in the stomach.

It appears from these experiments with *beer and wine* that the restraining effect which beer and wine have upon digestion is due to their contents of salts which bind the free HCl in the gastric juice. For the doses employed here their contents of alcohol play no part.

After a quantity of the beer and wine has been resorbed and has passed into the blood there occurs in *all cases an increased secretion of HCl and gastric juice respectively.* The effect of which in the course of a short or even considerable time counteracts the restraining effect of the salts. In the above eight experiments there are only three cases in which the restraining effects of beer and wine are noticeably marked after three hours.

The time which elapses before the beer or wine can counteract the restraining effect by increased secretion, appears to be dependent upon individual circumstances. In general it is not until two to three hours afterwards that the increased secretion appears to take effect. In the above three cases where the restraining effect is most pronounced, all the persons investigated were women. None of the women or men employed in these tests had previously drunk either beer or wine, and therefore inurement is out of the question.

Regarding the cause of the increase in secretion, it is not possible to make any definite pronouncement. It is conceivable that the increase is due to the taste and aroma of the wine and that in other words the »psychic« secretion was influenced. As in these tests persons were employed who had not previously drunk beer or wine, and who for that reason can scarcely have developed a taste for these drinks, it is not very probable that the »psychic« effect would play any part. It seems to be more probable that it is the constituents of the beer and wine which produced a »chemical« secretion. If we compare these experiments with those upon the effects of pure alcohol, it appears as if the effect is much greater and more constant, and the effect must mainly be attributed to the other constituents of the wine, the acids, salts and aromatic substances, somewhat like the extract substance of meat, aromatic tinctures and the like (Cp. Reichmann's investigations).

As stated previously, *Buchner* in particular finally concludes that beer and wine cannot have such a restraining effect upon digestion as that which at first he thought he had discovered by his experiments in vitro. He attributes this to the circumstance that the secretion of gastric juice removes the restraining influence of beer and wine. When on the contrary, he says, normal conditions of secretion are not present, such as in gastritis, the stomach acts like a glass retort and the restraining influence has full effect. He considers that this is the condition found in *vomitus matutinus*.

That such is not the case appears from these experiments. In experiment 85 (with landsøl) and in experiment 90 (with Rhenish wine) we have in the first case a patient suffering from achylia, and in the second from chronic gastritis. In these cases the secretion-promoting effect of beer and wine is just as great as in normal individuals, and beer and wine do not appear to have any restraining effect.

VIII. Resumé and Discussion of the Results of the Experiments.

1. The effects of Alcohol upon conditions of resorption.

It appears from our experiments (1 to 5) and with the doses there employed (about 0.5 ccms alcohol per kilo of bodily weight) that 75 % of the alcohol consumed has already disappeared from the stomach after half an hour and after one hour there is, practically speaking no alcohol left in it.

The experiments regarding the amount of alcohol in the smaller intestines during digestion (experiment 3 and 5) show that we find only small quantities of alcohol in it. *Resorption must therefore mainly take place from the stomach, and to a slight degree only from the intestine.* With larger doses the position is doubtless changed so that a larger quantity passes into the intestine.

The rate at which the alcohol is resorbed, as might be expected, *is dependent upon the degree of inflation of the stomach* (the size of the meal) the alcohol being resorbed more quickly in an empty stomach than in a full one. This appears from various experiments, and when the patient drank alcohol with his food, the alcohol disappeared from the stomach more slowly than in the experiments where the person concerned consumed alcoholic drinks without food. (Cp. for instance experiment 70). *Völtz, Baudrexel* and *Dietrich* (169) found by experiments upon themselves that the secretion of alcohol through the kidneys is dependent upon the degree of fulness of the stomach. This coincides closely with what has been stated above, according to which alcohol is resorbed more quickly in an empty stomach than in a full one. .

We should further expect that resorption would be dependent upon the pathological condition of the stomach, so that it would proceed more slowly with chronic gastritis than in a normal stomach. If, however, we compare experiments 90 with 91, where a man 22 years old suffering from chronic gastritis, was given the same dose of alcohol as a healthy woman, 22 years old (experiment 91), we shall find that the resorption of alcohol after three hours took place more quickly with the man suffering from chronic gastritis than with the healthy woman. In fact the concentration of alcohol is 0.07 and 0.10 % respectively. If we further compare them with experiment 92, we find that the concentration of alcohol in a man 17 years old was 0.08 % after three hours. *Thus chronic gastritis does not appear to prevent the resorption of alcohol in the stomach.* On the whole it appears that alcohol is resorbed quickly and easily through the mucous membrane of the body. Thus *Völtz, Baudrexel* and *Dietrich* (169) have shown that if they introduced 11 ccms of alcohol into the urine bladder of a dog, there were resorbed in the course of one hour 20—30 % and after two hours about 50 % and after six hours 95 %.

However, the result that the main part of the alcohol is resorbed in the stomach and not in the intestine, does not agree with Nemser's experiment (118) with dogs. He found that with these animals only 20 % of the alcohol was resorbed in the stomach, but in those experiments which were carried out according to E. S. London's fistula method, much larger doses were employed (e.g. 200 ccms in 20 % solution). It should further be noticed that for the determination of alcohol he used the pycnometer method which is not suited for these determinations. These investigations cannot therefore be compared with ours.

As opposed to Nemser, *Brandl* (18) found in his experiments with dogs that most of the alcohol was resorbed from the stomach, as did also *Lönnquist* (102) and *Volmering* (168). As these investigators constricted pylorus, the conditions are so far from being normal that the experiments only show that alcohol *can* easily be resorbed from the stomach.

Our experiments further show (Cp. 1, 3, 4 and 5, and also experiments 85—92) that with the doses here employed, *the alcohol has practically disappeared from the organism* (destroyed) after three or four hours. For after three hours there is only a small quantity left in the urine, and as the concentration of alcohol in the urine accompanies the concentration of alcohol in the blood (Cp. experiment 1) this means that most of the alcohol must have undergone combustion. Both *Gréhant* (61) and *Nicloux* (121) found that the concentration of alcohol in blood and urine accompany each other.

With regard to the combustion of alcohol in the organism the earlier investigators, as for instance *Volmering* (168) and Durig (36), appear to assume that alcohol slowly undergoes combustion in the organism. This is pointed out by *Geppert* (58) who found that a dose of alcohol of about 30 ccms does not exercise any appreciable influence upon the respiratory quotient in a human being.

Subsequent investigations, especially those of *Higgins* (73) indicate, however, that the combustion of alcohol commences as early as 5 to 10 minutes after entering the organism and that combustion proceeds very quickly. The article of consumption which appears to lie closest to alcohol with regard to combustion is sugar, which as Higgins remarks, appears to undergo combustion more quickly than alcohol. This combustion of alcohol appears to take place chiefly in the liver, as shown by the investigations of *Batelli* and *Stern* (155) who believe they have proved the existence in the liver of a ferment which oxydises alcohol (alcohol oxydase). That the combustion of alcohol takes place in the liver is also pointed out by *Pringsheim* (33) who also considers that this combustion proceeds more rapidly in animals accustomed to alcohol than in those which are not. *J. Hirsch* (74) also found that alcohol undergoes combustion in the liver and considered that he had found an alcohol oxydase there.

When the concentration in the blood increases, the oxydation in the organism will of course take a longer time, and a longer time will elapse before the alcohol disappears from the organism. Then as regards animals, *Völtz* and *Dietrich* (171) found that 2 to 3 ccms per kilo take 10 to 18 hours before the alcohol has undergone combustion. These doses are far too large, quite toxic doses in fact. If we gave proportionately large doses to human beings they would get a somewhat severe alcoholic poisoning.

As mentioned above, my own investigations show that the bulk of the alcohol (80 to 90 %) has already undergone combustion within the first three to four hours. After that time there are only negligible quantities left and this remainder has almost entirely undergone combustion after another 2 hours i.e. six hours in all.

Schweisheimer (147) stated that with a dose of 1.5 ccms alcohol per kilo of bodily weight, there is 0.055 % of alcohol in the blood after eight hours, and after twelve hours 0.013 %. *Toivo Seppa* (149) states that alcohol in small doses undergoes combustion in six to eight hours.

Only a small part of the alcohol consumed is secreted through the kidneys. It will be seen from experiments 1, 3, 4 and 5, where exact determinations of alcohol in the urine were carried out together with determinations of alcohol in the gastric contents, only 0.1 % and up to 0.5 % of the alcohol consumed is secreted through the kidneys. This agrees with the investigations of inter alia *E. Widmark* (179).

It appears from the investigations, that alcohol is an extremely easily resorbed substance, which the moment it has entered the stomach is absorbed through the mucous membrane and passes into the blood. It quickly undergoes combustion e.g. with small doses as quickly as in the course of 3 to 4 hours.

2. The influence of alcohol upon the proteolytic effects of natural gastric contents in vitro.

It appears from experiments 6 to 11 that alcohol has no effect upon the proteolysis of gastric juice in vitro, when the concentration of alcohol does not exceed 10 %. If the concentration of alcohol rises beyond 10 % it reduces the proteolytic capacity of the gastric juice by about 15 % i.e. to about one half the normal. By a concentration of alcohol of 20 % the alcohol prevents all proteolysis in vitro.

This agrees with earlier researches, inter alia those of *Chittenden* and *Mendel* (19) *Kast* (85) and others. When Chittenden points out that alcohol in slight concentration (1 to 2 %) appears to promote proteolysis in vitro (see page 39) this agrees with one of our experiments in which there was found a very considerable rise in the proteolysis with a concentration of alcohol below 10 %, but otherwise no certain increase in proteolysis is proved. The increase here in question is so small that it lies within the error of experiment.

The fact that alcohol in stronger concentration than 20 % prevents proteolysis, depends upon the effect of alcohol upon the pepsin, and is doubtless due to a precipitation of the latter.

3. The relation of alcohol to secretion in the stomach and the composition of the gastric contents.

It will be seen from experiments 12 to 27 that by giving small concentrated doses of alcohol (15 ccms aquavit) with light meals (Ewald's test breakfast) and also with rich (fat) meals, we usually find an increase in the gastric secretion, sometimes to a quite considerable degree (Experiments 12, 18, 19, 20, 21 etc.) but now and then we find no effects (experiments 15 and 16 etc.). Small concentrated doses of alcohol do not appear to have any constant effect in promoting secretion by *direct* effect upon the mucous membrane of the stomach. It is not clear where the causes of these variable results should be sought, and our experiments give no basis for a reply to this question.

Experiments 58—62 with large doses of alcohol (50 ccms of aquavit) show that by giving these doses *after* a meal there results no disturbance of gastric digestion. *A dose of this kind has a constant effect in promoting secretion* (see table of general results, page 72). Experiment 63 on the contrary shows that a dose as large as 50 ccms of aquavit *before* food (on an empty stomach) disturbs digestion to a considerable extent.

It appears to follow from experiments 1, 2 and 85 that it is not until *the alcohol has been resorbed that it acts in increasing secretion in small doses.*

We see from experiment 2 how secretion of gastric juice normally takes place from a quarter of an hour to half an hour after the taking of a meal. At first no free HCl is found in the gastric contents, as the acid has been bound to the salts and albuminous substances present in the food, but after half an hour the free HCl is demonstrable and gradually increases. This increase takes place more quickly in the meal with alcohol (experiment 1) in which the free HCl after two and a half hours has increased by about 50 % in proportion to the check meal (Experiment 2) Cp. also the concentration of hydrogen-ions where P_H is 1.6 and 1.8 respectively. Here the secretory effects of alcohol do not appear until one and a half hours to two hours after the meal.

The fact that alcohol acts in promoting secretion of the gastric juice has been previously pointed out by a number of authors, e.g. by *Chittenden* (28) *Gluzuicky* (60) *Zitowitsch* (182) *Kast* (85), *Lönnquist* (102) and *Klemperer* (90) and *Blumenau* (12) in experiments upon dogs. The fact that Kast asserts that alcohol causes an increase in HCl but not in pepsin is due to incomplete methods of investigation in the digestion experiments.

In what manner and by what means does alcohol act in augmenting secretion?

From the above experiments it is not probable that this depends upon a direct effect upon the mucous membrane of the stomach, or upon the glands of the stomach, for the time taken for the secretion to come is too long. The secretory effect does not develop even relatively until long after the alcohol has been resorbed from the stomach. It is not until the alcohol has entered the blood that it exhibits its secretory effects. The question then arises, in what manner is this effect exercised? There are in advance two principally different possibilities open: Either it is due to an influence from the central nervous system upon the secretory nerve system of the stomach, or it is due to an increase of substances causing secretion which are formed in the mucous membrane of the stomach by resorption, and are brought into the circulatory system and act direct upon the glandular apparatus. The presence of such substances in the stomach, known as secretines, must be regarded as certain. Whether they act specifically upon the secretion of gastric juice is another question. According to *Edkin's* (39) investigations on the conditions of secretion in the digestive canal, these secretines appear to originate in the pylorus portion of the stomach. *Maydell* (131) confirms these investigations, whilst *Ehrmann* (40) considers that other organic regions act in promoting secretion and that these secretines are found in organs outside the digestive canal. *Popielski* (131) found secretines both in the fundus mucous membrane of the stomach and in the rectum mucous membrane, and considers therefore the Edkin and Maydell secretines are not specific.

Our investigations give no basis for a decision in this matter, but it is most probable that the increase of secretion is due to the effect of alcohol upon the nervous system on account of its generally exciting action.

4. The effect of alcohol upon the psychic secretion of gastric juice.

Investigations of the «psychic» secretion will of course always be variable and uncertain. According to the experiments made (64 to 70) the psychic influence of alcohol appears to be of less importance than had been expected.

By the sight, smell and taste of beer and dram we do not obtain any increase in the quantity of gastric juice secreted, but on the other hand an increase in the quantity of free HCl (See also page 81).

5. The influence of alcohol upon the motor functions of the stomach.

The influence of alcohol upon the motor functions of the stomach (experiments 71-82) appears to be closely connected with the effects of alcohol in promoting secretion. On account of the increased secretion the food can be more quickly digested, and be ready more quickly to leave the stomach. It is particularly the increase in the free hydrochloric acid in the contents of the stomach which can give rise to a more rapid motor action. It is thus *indirectly* that alcohol may be said in certain cases to increase the motor functions. With the small concentrated doses employed in the experiments (15 ccms aquavit) it has not been possible to prove any *direct* effect upon the motor functions. On the other hand it has also not been possible to show any retentive effect (See page 90).

6. The effects of beer and wine upon gastric digestion.

The direct effect in promoting secretion which is now and then found with small doses of concentrated alcohol is not present in the case of beer and wine.

In the first place, both beer and wine (on account of the salts they contain) bind the free HCl of gastric juice, as we saw in the experiments in vitro (Nos. 83 and 84) but as by degrees the beer and wine are resorbed, a more copious secretion of gastric juice commences. (Experiments 85 to 92) and in the course of three hours this may even increase the proteolytic capacity of gastric juice by about 60 %. (Cp. experiments 91 and 92). We here find *a constant effect of promoting secretion* with an increase in both the free and the bound HCl and the total acidity (see table of general results Page 104). However it is doubtless not only the alcohol which causes the increased secretion, but also the extracts in the beer and wine.

Reichmann (132) is of course correct when he finds in his experiments that the bitter secretion-promoting agents act best when taken before meals (half an hour before food). But when he says further that these agents if given during a meal have less beneficial effects or even disturb digestion, his statement is erroneous. It is true that the effect comes later and is not quite so powerful, because these bitter agents are resorbed more slowly on a full stomach than on an empty one, but they certainly take effect and promote digestion. In digestion experiments outside the organism we often obtain such misleading results because there is not present the capacity of the organism to adjust the relation between pepsin and concentration of hydrogen-ions. This error is apparent in *Bluchner's* (19) *Cramer's* (35) *Chittenden's* (28) and *Chase's* (34) experiments with beer and wine *in vitro* (see page 91).

7. The effects of alcohol upon the composition of the secretion and gastric contents with a pathological condition of the stomach.

With respect to the various gastric diseases the effects of alcohol vary very greatly, as will appear from experiments 28 to 56. In the case of patients suffering from *hyperacid dyspepsia and ulcus ventriculi,* (experiments 28 to 32 and 38 to 49) the effect was an increase in the quantity of HCl and the total acidity, and as these patients most often have a sufficiency of gastric juice, (cp. experiments 30, 46, and 47) the alcohol helped to increase the pyrosis and pain (as in experiment 47). We should therefore as a rule not use alcohol with such patients.

In the case of patients with *cancer ventriculi* (see page 58) alcohol does not act upon the secretion of gastric juice, but it sometimes appears to have the effect of relieving pain and to some extent to remove feelings of fulness and nausea. (Cp. experiment 37).

As regards patients with *nervous dyspepsia* (see page 64) the invidual conditions, age and sex appear to play a certain part. With elderly men (experiment 42) suffering from hypochlorhydria and hypacidity, we can see the use of alcohol with meals, whilst with female patients (e. g. experiment 39) and young men (experiment 40), who are not accustomed to alcohol in any form, we should be extremely cautious about prescribing alcohol as medicine.

In the case of patients with «*achylia gastrica*» and chronic gastritis small quantities of alcohol may prove to increase proteolysis in the stomach. In these conditions there is a diminished secretion of gastric juice with a lack of or reduction in the free HCl in the gastric juice. As alcohol has a secretory effect (see experiment 50 to 54) it will promote gastric digestion. We find amongst our experiments several cases in which alcohol has produced free HCl in a gastric juice where it was otherwise lacking (e. g. in experiments 50 and 51). In such cases alcohol will naturally promote gastric digestion to an appreciable degree.

If complete achylia (an entire absence of secretion of gastric juice) is present, alcohol has no secretory effect (experiment 52). Gastritis does not appear to be a contra indication. See page 107.

Finally, we will see to what extent our experiments give material for elucidating the problem of the

therapeutic value of alcohol as a stomahicum and indications for its employment in that direction.

Our experiments show that a small dose of alcohol (15 ccms of aquavit) with a meal, increased in a number of healthy persons the quantity of gastric juice, its contents of HCl and its digestive capacity. (See tables of general results pages 50 and 90). It is true that this increase was not considerable in most cases, (only 10 to 20 %) but it undoubtedly assisted the work of digestion in the stomach, and in these cases the motor functions proceeded more easily and quickly. But this effect is not constant. In two cases it was not possible to show any change in secretion (see page 51. Nos 4 and 5), which falls within the customary variations. None of the experiments performed show any injurious influence upon gastric juice.*

Also in a number of pathological conditions and in anomalies of secretion, anacid and achylic conditions, the same small dose of alcohol (15 ccms of aquavit) increased the quantity of secretion of HCl and the digestive capacity. (See experiments 50, 51 and 55, and also 78 and 79) whilst in other cases it had no effect upon the functions of the stomach. (See experiment 56). It is not astonishing that this should be the case where secretion had completely ceased (see table of general results (page 59). Also in cases which clinically appear to have been quite homogeneous, the effect has varied without there appearing to be any tangible cause (see table of general results page 64). In one case (No 11) there even appears to have been a lowering effect with reduced HCl.

On the whole, the effect of these small doses of alcohol upon the function of the stomach, under pathological conditions as well, appears to be highly dependent upon *individual conditions*, a circumstance which may well be so explained that the alcohol in the last instance exercises its influence upon a nerve system the receptivity and reaction capacity of which may vary considerably.

Even though we cannot draw general conclusions from the experiments under consideration, as concerns indications for the employment of alcohol in anomalies of secretion in the stomach, yet we may say that in the majority of cases it augments secretion and thereby facilitates that function, but of course there can scarcely be any doubt that the effect is quite symptomatic and that there is no question of any durable or lasting effect upon the secretory apparatus.

* Wiht larger doses, up to 50 ccms of aquavit, a more constant effect in increasing secretion appears (see table of general results page 72), indicating that alcohol must be regarded as a means of promoting secretion.

Taking everything into consideration however, it may be said that the ancient reputation of alcohol as a stomachicum has received a blow, although a conditional one, in the investigations under consideration. This especially applies to the slighter forms of anomalies of secretion. If we consider how many people there are who without being ill otherwise, suffer from these complaints, we shall not wonder at the opinion, so widespread amongst medical men and laymen, that alcohol produces a facilitation of digestion in the stomach. Amongst the individuals of my own experiments it was constantly found, that without knowing anything of it, they suffered from anomalies of secretion, with reduced or lacking HCl in the stomach. This was particularly the case with somewhat elderly individuals. Amongst healthy persons over 50 years of age, I found a deficiency of free HCl in 32 % (65) and if I include those with a considerably reduced quantity of HCl the figure increases to 50 %. This agrees with earlier investigations. such as those of *Seidelin* (150), and according to *Faber* (45) depend upon gastritis increasing with age. These persons, who thus make up a great part of the population, will as a rule not feel any digestive troubles as far as the stomach is concerned when their food is suitably composed and well prepared, but if they live and, as happens not infrequently in life, they are obliged to live on unsuitable and badly prepared food, that requires a strong gastric digestion and good motor functions if the contents are not to stagnate in the stomach, these troubles will at once arise. It is here that in certain cases alcohol may help over the difficulties.

It goes without saying that the doses and strength employed must never exceed the limits at which chemical effects upon the pepsin appear. As our experiments in accordance with those of others have shown, these limits are situated at 10 % of alcohol in the total gastric contents.

With regard to the relation of the alcoholic drinks, wine and beer, to digestion of the stomach the position is even more complicated (see under beer and wine, p. 91). Much of their secretion-promoting effect must be ascribed to «extract» substances, both organic and inorganic, and the effects will vary with these latter.

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