METHODS OF DETERMINING FLAVOR CONSTITUENTS IN MEAT

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There are many papers in the scientific literature dealing with tenderness, some with juiciness, but only a few with flavour and aroma. This paper is a review of research methods which have been used in the work on flavour and aroma.

Most of the recent work has been done with poultry meat. Nothing has been found, however, that would indicate that the principles established in flavour work with poultry meat would not apply to the so-called "red meats". Some of the research methods which have been developed may be useful in devising a quantitative method for flavour evaluation. These methods would certainly be of value as a basis for further work on the identification of flavour constituents.

Preliminary Observations

Salomon (1943) observed that raw meat did not have meat flavour but that the flavour was present after the meat was cooked.

Crocker (1948) reported some work which indicated that meat flavour was developed in the muscle fibres during cooking. Beef, pork, lamb and chicken were used in the experiments and it was stated that results were similar for all of the meats.

The flavour of raw, fresh, lean meat was described as "blood-like". The juice was extracted from the lean meat by pounding, squeezing in a hydraulic press and leaching in water. The juice was found to have the "blood-like" flavour and the raw fibre practically no flavour.

Boiling the juice did not produce the meat flavour. Boiling the separated fibre, however, did produce the typical meat flavour. When the cooked fibre was chewed while the nose was open, the meat flavour was experienced. The flavour was not experienced, however, if the nose was closed during chewing. This would indicate that the constituents of meat flavour were volatile under these conditions. Meat flavour seems to be detected as an odour or aroma by the olfactory center at the top of the nose. The taste buds in the mouth probably do not make a major contribution to the experience of meat flavour. It is a well-known fact that it is useless for a person with his nasal passages blocked due to a head cold to participate on a taste panel.

It was found by Crocker that beef flavour could be steam distilled. The pH of the distillate was 9.3 compared to 5.9 for raw beef. It was also reported that fat, bone and bone marrow did not contribute to meat flavour, but the methods used to demonstrate this finding were not presented. This
observation has been supported by work with chicken reported by Pippen et al. (1954) who found that bones and skin did not contribute much to chicken flavour.

A number of very interesting methods were used by Bouthilet (1949, 1950, 1951a, 1951b) in a series of experiments on the development, extraction, concentration and fractionation of the flavour constituents of chicken meat.

**Development of Flavour**

Ground chicken was cooked in water at various temperature and time combinations to determine the optimum conditions for preparing a broth. It was found that temperatures over 100°C. produced a burnt odour. The best broth was produced by gentle simmering of chicken in water, equal parts by weight, for 24 hours at temperatures just below 100°C. Complete development and extraction of flavour from the muscle fibre was obtained in 48 hours.

**Extraction of Flavour from Broth**

Three methods were used for extracting flavour constituents from chicken broth. In one method, the broth, including the muscle fibre, was dialyzed against cold distilled water by means of a cellophane membrane. The flavour was found in the dialyzate.

In another method, a flash still or steam stripper was used to remove the flavour constituents from the broth. It was found necessary to first remove the fat from the broth by permitting it to stand until the fat solidified and then filtering through glass wool. It was also necessary to keep the solutions hot during processing to prevent the accumulation of gelatin on the apparatus.

The third method used for extraction was a low pressure steam distillation procedure. It was necessary to keep steam pressures below 5 pounds to prevent the formation of a burnt odour.

**Concentration of Flavour**

Two methods were used for concentrating the flavour constituents. In one method, Duolite A-3 and C-3 ion exchange columns were used to separate the flavour constituents from the water dialyzate obtained from chicken broth. The flavour was absorbed into the anion column from which it was eluted with sodium hydroxide. The flavour constituents were then further purified by steam distillation of the eluate. It was necessary to neutralize the eluate in order to distill the flavour from it. Difficulty was experienced in condensing the vapour due to acidic components carried over with it.

In the other method, a still with a reflux fractionating head and a 10-plate, Bruun type, bubble-cap column was used to concentrate the flavour constituents contained in the distillates from the flash still and low pressure steam still. The distillation was carried out at atmospheric pressure and a temperature of about 100°C. Each run through the fractionating still
was reported to increase the concentration 10 times. A flavour concentrate 10,000 times as strong as the original broth was prepared by this method. This concentrate was very unstable unless refrigerated at the temperature of dry ice.

An interesting technique was used by Bouthilet to estimate the concentration of flavour in the flavour extracts. A series of dilutions in multiples of ten was prepared by mixing one millilitre of flavour concentrate with 9 millilitres of water, then in turn mixing one millilitre of the first 1:10 dilution with 9 millilitres of water, and so on for succeeding dilutions. The different concentrations were tasted to determine the greatest dilution at which the flavour could be detected. Further refinements of the dilution ratios were then made to estimate the flavour threshold more accurately. A basal medium was added to the samples to be compared with the original broth, in order to simulate the properties of broth, other than flavour.

**Fractionation of Flavour**

Three methods were used to separate the flavour constituents into fractions. In one method, two runs through the fractional still described above were made to produce a 100-fold concentration. It was observed that the first 20 per cent of the distillate possessed the true chicken flavour and the remainder had a "meaty" flavour, indicating that there were two separate flavour constituents.

The flavour concentrate from the second run through the fractionating still was treated with mercuric sulfate and the precipitate was removed by filtration. The filtrate was again run through the fractionating column. The concentrate obtained was found to have a "fatty-acid-like" odour, indicating the presence of a third flavour constituent.

In another method the flash still referred to previously was used under conditions of high vacuum. The distillate from low pressure steam extraction of chicken broth was acidified and distilled over at high temperature into a series of three traps cooled in turn by ice and salt, dry ice and acetone, and liquid nitrogen. Two flavour constituents were separated by this method. The dry ice trap contained material with a fatty-acid-like odour and the liquid nitrogen trap contained a yellow, oily material with a chicken odour.

The third method for fractionation of flavour constituents consisted of a solvent extraction procedure. The distillate from low pressure steam extraction of chicken broth was acidified and again distilled. The acidic distillate was extracted with isopentane in a liquid-liquid extractor for 10 hours. Absolute alcohol was added to the solvent extract and the isopentane removed by evaporation. The alcohol solution was filtered and stored at -20°C. A white fatty-acid-like material settled out of solution and was removed by filtration. A yellow oily material left in solution had a chicken odour. The water solution left after the isopentane extraction also had the chicken odour.
Conclusion

The pyrogenic flavour development which occurs at the surface of meat exposed to high temperature was not studied in the work reviewed. Chicken flavour was separated into three constituents, a meaty flavoured portion, a characteristic chicken flavoured portion and a fatty-acid flavoured portion. It would be interesting to learn if the flavours of beef, pork and lamb are composed of similar constituents.

On the basis of the research methods presented, it may be suggested that meat flavour is best developed by cooking at temperatures slightly below 100°C. The flavour constituents may be extracted by dialysis or steam distillation. They may be concentrated by ion exchange or fractional distillation. The flavour constituents may be separated by fractional distillation, high vacuum steam distillation and solvent extraction.

It was not possible to include in this review the many analyses which were made in attempts to identify the flavour constituents or the many speculations about known compounds which may be related to the flavour constituents.

Bibliography

   A note on the nature of chicken flavour.
   Food Tech. 3 118 (1949).

   Chicken flavour: separation and concentration of its volatile components from broth.
   Food Res. 15 322 (1950).

3. Bouthilet, R. J. 1951 (a)
   Chicken flavour: the fractionation of the volatile constituents.
   Food Res. 16 137 (1951).

4. Bouthilet, R. J. 1951 (b)
   Chicken flavour: the source of the meat flavour component.
   Food Res. 16 201 (1951).

   Flavour of meat.
   Food Res. 13 179 (1948).

   Flavour studies. Origin of chicken flavour.

   The meat flavour.
   Food Manufacturing 18 61 (1943).
MR. AUNAN: Thank you, Bob.

Dr. Vernon Johnson will lead the discussion on this paper.

MR. JOHNSON: You have heard the thorough discussion on the methods of determining flavor constituents of meat. Do you have any questions that you would like to direct to Bob or anyone else? I think you did a good job, Bob.

MR. AUNAN: I think before we go any further we will ask Lyman Bratzler if we can have a break. Is it all right with you, Lyman? We might be imposing on the line of thought that has been stirred up here by the last couple of papers.

MR. WANDERSTOCK: Why don't we have Lyman's summary and then the break?

MR. AUNAN: All right, Lyman, if you will take over and give the summary discussion at this time, please.

MR. BRATZLER: The question has been raised as to whether or not we will take the break during the summary. It is perfectly all right, gentlemen.

It seems presumptuous for me to summarize after the various papers have been discussed. I am not as young as some of the young ones. I used to think I was, but as the years go by we gradually begin to feel a little older.

I have just a few points that I think might summarize the excellent presentations of the Research Methods Committee.

I think my biggest impression from listening this afternoon is the little progress we are making and have made and the need for continued effort along the lines of research methods.

First of all this morning on the estimation of body composition I think we can compliment the gentlemen who have done the work, whether in this group or in other groups. They have used quite a bit of imagination and ingenuity in their various approaches. I heard some comment that it does not work, but I think we should not be deterred by observations of that kind.

One thing I was impressed by and I have always been and have tried to maintain is cooperation with research personnel in other departments. In meats we think along one line and we too often overlook a lot of information that our cohorts or our cooperators are interested in, particularly in this hormone work, flavor work, etc. I am sure we could get considerable help by having more active cooperation.

On methods of measuring color I have only one note here. This, of course, is on the carbon monoxide treatment. The first letter we got back was more or less a brush-off saying that it had been reviewed, etc., and that there was no use of going any further but I could
not be quieted quite that easily, and the second letter left the door open as to whether or not the method will be approved. In other words, anything that we suggest that will tend to increase the chore of inspection I think will not necessarily be frowned on -- well, you know, just like when you and I are going along and somebody suggests a new method that may involve a little additional work or thinking we will say "no," but if the man is persistent we will change our minds.

I think Bill Sulzbacher hit upon one thing. I am rather intrigued with the idea of harnessing these bacteria to help us, not thinking of them only from a negative standpoint but as also having a positive angle.

Also the matter of plant sanitation. Always the shoe fits a little and I know that Butler will think that surely it should fit on this matter of plant sanitation. One thing we did learn from O. D. We at least learned how much detergent to use and how often. Another thing that Bill told us that is very helpful to those of us who are interested is where to go for information. None of us is capable of remembering everything and if we know where to go for information that is very helpful.

The matter of assaying drugs and hormones brings up a point that I have been concerned with. The Pure Food and Drug and also I suppose the Meat Inspection Branch who are not too familiar with that rely considerably on the results that come from our experiment stations. I don't think we should think of ourselves as one experiment station in trying to promote something in a hurry to be first, whether or not it is right, because the reputations of all the experiment stations are at stake, I think, in some of these problems, particularly when it comes to the residual effects of some of these drugs, feed additives, implantations, etc.

If you will look back through last year's proceedings you will find that Mr. Herring gave a pretty good explanation of how the Pure Food and Drug Administration will react to any application.

On meat composition I am glad to hear that we have no measurement of tenderness that is accurate. I fully agree with that. I understand that one has been patented by Paul Gazer down at Swifts and I am sure that there is considerable room for improvement on this subject.

As to flavor it goes without saying that each of us have our own appreciation and flavor desires, and I think along this line that we should as meats men pay more attention to what flavor the consumer would like and looks for. Why develop a type of hog or a kind of meat without consulting the consumer? Why try to sell something that needs selling mainly because we think it is right? The same thing is true of flavor.

MR. AUNAN: Thank you, Lyman, for that fine review.

At this time I should like to thank the members of the committee who were so gracious as to present ideas for papers and also the
participants for the fine manner in which they gave their papers. I think they deserve a big hand, and I certainly do thank them from the bottom of my heart.

CHAIRMAN KLINE: Just two announcements before we break for just a minute. We have a few newcomers in our midst since our last introductions. We have heard from one of these gentlemen from time to time. Dr. Schulz, from the Food Technology Department at Oregon, who is right behind me here.

We have a gentleman over there by Marshall Heck, Mr. Hardin from the Farm Bureau in Arkansas.

Then a gentleman right over there next to Phil Anderson, who is rather familiar to this group, Professor Loeffel from Nebraska.

And over by Larry Kunkle is Dean Weber from Kansas State.

Is there anybody whom I have overlooked?

Dr. Kraybill was here. I guess he has stepped out. Dr. Kraybill is from the American Meat Institute Foundation.

Now we are going to recess for five minutes. Don't forget the little box.

(Recess.)

CHAIRMAN KLINE: I think that at this time according to the program we should call on George Wellington, Chairman of the Teaching Committee, to make some announcements with regard to the next two days. George.