## Production of a flavouring with meat-like sensory properties from slaughter animal blood

KRISTEN FRETHEIM, JOHN NORDAL and ERIK SLINDE

Norwegian Food Research Institute, P.O.Box 50, N-1432 Aas-NLH, Norway

Slaughter animal blood has remained an underutilized resource due to its colour and flavour characteristics. In search for new possibilities we have considered producing a flavouring with meat-like sensory properties by subjecting blood to hydrolysis.

When bovine blood was hydrolysed with HCl at 115-120°C in a closed vessel for 12 hours, it was found that a volume ratio of concentrated acid to blood less than approximately 1 : 10 will not give an acceptable product. The best flavour was obtained by using a very high concentration of acid (1 : 1.7); however, neutralization yielded this product extremely salty. Analyses (precipitation with trichloroacetic acid and protein determination by the Lowry procedure) indicated that acid concentrations above 1 : 3 have very little effect on the hydrolysis. It should be realized that hydrolysis largely destroys the nutritional assets of blood; the obtained product is low in heme-iron and amino acids have also been destroyed.

Our main interest was focused on improving the innately poor sensory characteristics of the hydrolysates by subsequent treatment. We have found that deodorization by treating the neutralized solutions with steam has very favourable effects. Fractionated dissolution and filtration improved the desired properties further.

## Herstellung von einem Geschmacks-Präparat mit fleisch-ähnlichen sensorishen Eigenschaften aus Schlachttierblut

KRISTEN FRETHEIM, JOHN NORDAL und ERIK SLINDE

Norwegishes Institut für Nahrungsmittelforschung, P.O.Box 50, N-1432 Aas-NLH, Norwegen

Wegen seiner färblichen und geschmacklichen Eigenschaften wird noch Schlachttierblut unbefriedigend als Nahrungsmittel ausgenützt. Beim Suchen neuer Möglichkeiten, haben wir Herstellung von einem Geschmacks-Präparat, mit fleisch-ähnlichen sensorischen Eigenschaften, durch Hydrolyse von Blut durchgeführt.

Wenn Rinder-Blut mit HCl bei 115-120°C in einem verschlossenen Behälter 12 Stunden hydrolysiert wurde, fand man, dass Volumenverhältnisse weniger als 1:10, zwischen konzentrierter Säure und Blut, kein annehmbares Produkt gaben. Beim Verwenden von sehr hoher Säurekonzentration (1:1,7) erhielt man den besten Geschmack, doch durch die Neutralisation wurde dieses Produkt ausserordentlich salzig. Analysen (Fällung mit Trichloressigsäure und Proteinbestimmung nach Lowry) zeigten dass Säure-Konzentrationen höher als 1:3 eine sehr kleine Wirkung auf die Hydrolyse ausübte. Man muss darauf aufmerksam sein, dass eine Hydrolyse zum grössten Teil die Ernährungs-Vorteile des Blutes zerstört. Das erhaltene Produkt hat wenig Heam-eisen, und Aminosäuren sind auch zerstört worden.

Unsere Hauptinteresse war die natürlichen schlechten sensorischen Eigenschaften der Hydrolysate, durch neue Behandlugen zu verbessern. Man hat festgestellt, dass Desodorisierung von den neutralisierten Lösungen mit Wasserdampf eine sehr erfolgreiche Wirkung hat. Durch fraktionierte Auflösung und Filtration sind die beliebten Eigenschaften noch weiter verbessert worden.

# 10.8

## Production d'un arômatisant de propriétés sensorielles similaires à la viande, à partir d'équarrissage

KRISTEN FRETHEIM, JOHN NORDAL et ERIK SLINDE

Institut Norvégien de Recherche Alimentaire, P.O.Box 50, N-1432 Aas-NLH, Norvège

Le sang d'équarrissage est resté une ressource insuffisamment utilisée à cause de sa couleur et de son goût. A la recherche de nouvelles possibilités, nous avons envisagé la production d'un arômatisant de propriétés sensorielles similaires à la viande en soumettant le sang à l'hydrolyse.

Lorsque le sang bovin est hydrolysé à l'acide chlorhydrique, a 115-120°C, dans un récipient clos' durant 12 heures, et lorsque le rapport du volume d'acide à celui du sang est légèrement inférieur à un pour 10, le produit obtenu n'est pas satisfaisant. Le meilleur arômatisant fut obtenu a une concentration très élevée en acide (1 pour 1,7). Cependant, après neutralisation, ce produit est extrêmement salé. Des analyses (précipitation par l'acide trichloracétique et détermination des protéines par le procedé de Lowry) indiquent que des concentrations en acide supérieures à 1 pour 3 n'ont qu'un très léger effet sur l'hydrolyse. Il faut tenir compte du fait que l'hydrolyse détruit en grande partie les qualités nutritives du sang; le produit est pauvre en fer du groupe hème et les acides aminés furent également détruits.

Notre principal objectif est d'améliorer les caractéristiques sensorielles foncièrement médiocres de ces hydrolysats par des traitements ultérierus. Nous avons trouvé que la désodorisation obtenue en traitant les solutions neutralisées par la vapeur a des effets favorables. Par dissolution fractionnée et par filtration, nous améliorons encore les propriétés désirées.

## Производство препарата со вкусом мяса из крови животных,мясо которых идет в пищу

КРИСТЕН ФРЕТХАЙМ, ЮН НУРДАЛ и ЭРИК СЛИНДЕ

Норвежский Исследовательский Институт пищи
(Norsk institutt for næringsmiddelforskning,P.O.Box 50, N - 1432 Aas-NLH, Norvège)

Кровь животных,мясо которых употребляется в пищу,была не удовлетворительным образом используемым ресурсом из-за специфических цветовых и вкусовых характеристик. В поисках новых возможностей использования такой крови,мы сделали попытку создания препарата со вкусом мяса путем подвергания крови гидролизу.

После того,как кровь крупных рогатых животных была подвергнута гидролизу с соляной кислотой (HCl) при температуре 115-120°C в закрытом сосуде в течение 12 часов, было установлено,что отношение объёма концентрированной кислоты к объёму крови меньшее,чем приблизительно 1:10,не дает удовлетворительного результата. Лучшие вкусовые качества и запах имеют место при использовании сравнительно высоких концентраций кислоты (1:1,7); однако,в результате получается очень солёный продукт. Анализ (преципитация с трихлоруксусной кислотой и протеином в роли определителя по Лаури (Lowry)) показал,что концентрации кислоты выше 1:3 оказывают очень небольшой эффект на гидролиз. Следует заметить,что гидролиз в большой степени снижает питательную ценность крови; полученный продукт имеет низкое содержание железа в крови и теряет аминокислоты.

Нашей основной целью было улучшение чувствительных характеристик продуктов гидролиза дальнейшей обработкой. Было найдено,что дезодорация полученных продуктов паром после нейтрализации дала очень хороший эффект. Последующее разделение раствора на компоненты и фильтрация еще более улучшили качества продукта.

# Production of a flavouring with meat-like sensory properties from slaughter animal blood

KRISTEN FRETHEIM, JOHN NORDAL and ERIK SLINDE

Norwegian Food Research Institute, P.O. Box 50, N-1432 Aas-NLH, Norway

Slaughter animal blood is still an underutilized resource, among others because the hemoglobin of the red cells gives blood-containing products a dark colour on heating or fermentation. Centrifugal separation of whole blood yields about 60% plasma and 40% of a red cellular fraction, containing about 1/4 and 3/4 of the total blood proteins, respectively. Plasma has been shown to have good emulsion stabilizing and gelation properties (Tybor *et al.*, 1975; Hermansson and Tornberg, 1976; Fretheim and Gumpen, 1978) and is used as an ingredient in comminuted meat products in some countries. On the other hand, the processing of the cellular fraction to yield a decoloured protein product is as complex as has been experienced with whole blood (Tybor *et al.*, 1975; Stachowicz *et al.*, 1977; Wismer-Pedersen, 1978; Hald-Christensen, 1978).

In search for new possibilities we have studied some aspects of the production of a flavouring with meat-like sensory properties by hydrolysis of whole blood.

## MATERIALS AND METHODS

Hydrolysis. Fresh blood containing 0.4% anticoagulant (trisodium citrate·2 $H_2O$) was obtained at a slaughterhouse. Samples (200 ml) were prepared by adding appropiate amounts (Table 1) of hydrochloric acid and water to the blood while stirring. Two sets of the resulting suspensions, of which sample E was paste-like, were hydrolysed at 115-117°C in an autoclave for 2 times 6 hours. The hydrolysis process was further studied in a separate experiment. Blood (50 ml), concentrated hydrochloric acid (30 ml) and water (250 ml) was autoclaved for four periods of two hours separated by withdrawal of samples for analysis.

Table 1. Composition (ml) of samples subjected to hydrolysis

| Samples | Blood | Conc. HCl | Water |
|---|---|---|---|
| A | 125 | 75 | 0 |
| B | 150 | 50 | 0 |
| C | 150 | 25 | 25 |
| D | 150 | 10 | 40 |
| E | 150 | 5 | 45 |

Refinement. The hydrolysates obtained were neutralized (pH 6.0) with sodium hydroxide (40%) and the total volume of each sample was adjusted to 580 ml with water. Deodorization was carried out on one half of the sample volumes as follows: An amount of steam equivalent to approximately 300 ml of water was passed through each sample in the course of one hour. The hydrolysates were then freeze-dried and ground to a free-flowing powder.

Further refinement was achieved by treating the dry material with hot water. The resulting viscous suspension was filtered through a glass sinter, freeze-dried and ground.

Sensory evaluation. A preliminary evaluation of the preparations was carried out by putting a small amount of dry material on the tongue. The sensory evaluation proper was performed by a panel of five judges on samples in which the salt content had been adjusted to the same

level. In separate evaluations the judges were asked to (1) rank the deodorized samples A, B, and C according to their degree of meat-like flavour and abscence of off-flavour, and (2) to compare deodorized and non-deodorized sample A. The product improvement achieved by fractionated dissolution and filtration was evaluated by three judges in a similar fashion.

Chemical analyses. Heme was determined by the pyridine hemochrome method as described by Furhop and Smith (1975). Protein was determined by the method of Lowry *et al.*(1951). Trichloroacetic acid (TCA) precipitation was performed at a final concentration of 10%.

RESULTS

Sensory evaluations. Preparations D and E, deodorized or not, were found unacceptable by the preliminary evaluation. The deodorized preparations A, B and C were easily ranked as summarized in Table 2. Preparation C was unambiguously ranked as No. 2 with regard to meat-like flavour and absence of off-flavour, but its overall flavour was unfavourably influenced by a slight bitterness.

Table 2. Sensory evaluation of deodorized preparations of equalized salt content.

| Preparation | Amount (g) dissolved in boiling water (100 ml) Dry material | Salt | Ranking |
|---|---|---|---|
| A | 6 | 0 | 1 |
| B | 4.2 | 1.8 | 3 |
| C | 3.1 | 2.9 | 2 |

When preparation A was studied to evaluate the effects of deodorization, all five judges detected a strong off-smell in the non-treated sample. The overall impression of the deodorized product was largely pleasant (aside from saltiness), while the non-treated preparation was deemed unacceptable. Further studies revealed the observed favourable effect of deodorization to be generally true. The sensory properties of the product obtained by fractionated dissolution and filtration were judged to be further improved.

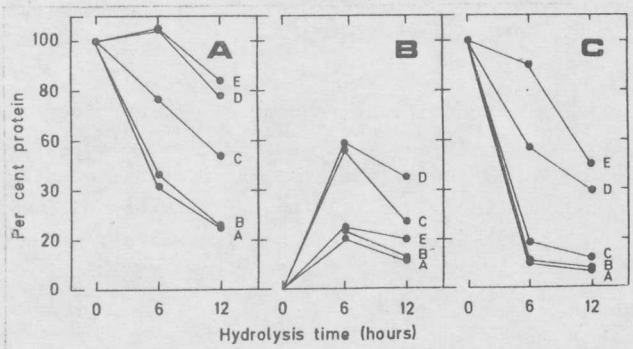


Fig. 1. Hydrolysis of blood using different concentrations of hydrochloric acid. The samples are described in Table 1. Remaining Lowry positive material after hydrolysis (A). Remaining Lowry positive material in supernatant (B) and pellet (C) after precipitation with TCA.

Characterization of the hydrolysis process. Fig. 1 shows the hydrolysing effect of different concentrations of hydrochloric acid on blood under the conditions used. From Fig. 1A it is seen that the total amount of protein in the hydrolysed samples (measured by the Lowry method) decreases with increasing concentrations of hydrochloric acid. The amount of TCA precipitable material decreases as the concentration of hydrochloric acid increases (Fig. 1C). In contrast, the protein recovery in the supernatant shows that an intermediate concentration of hydrochloric acid gives the highest amount of Lowry positive material (Fig. 1B).

The hydrolysis process is further characterized in Fig. 2. From Fig. 2A it is seen how the amount of Lowry positive material decreases with time, while Fig. 2B shows that (1) the amount of TCA precipitable protein remains constant after two hours and (2) there is a decrease in Lowry positive material in the supernatant with time. The two curves of Fig. 2B

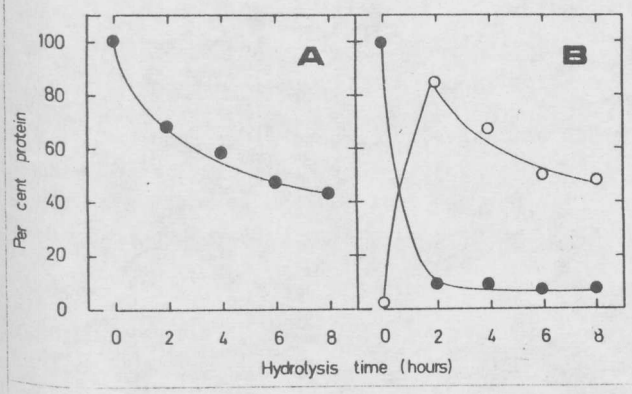


Fig. 2. Hydrolysis of blood. Decrease in Lowry positive material with time (A). Remaining Lowry positive material during the hydrolysis process, in supernatant (o) and pellet (•) after precipitation with TCA.

imply that hydrolysis of polypeptides to amino acids and destruction/rearrangement of amino acids take place as the hydrolysis process progresses.

The amount of heme was found to decrease abruptly to only a few percent during the first two hours of hydrolysis and decreased further to only 1-2 percent of the original amount.

## DISCUSSION

If a meat-like flavour product is to be found acceptable or, preferably, appealing by the consumers, we assume that it must be free from the characteristic taste, smell and colour of blood. The product obtained by simple hydrolysis satisfies these demands, but to our experience a bad off-flavour is formed during the process. This problem has to be overcome for blood hydrolysis to become commercially interesting.

In the course of our work we became aware of a recent Swedish patent which describes the preparation of a bouillon concentrate by hydrolysis of blood or its cellular fraction (Hellqvist, 1978). The acid hydrolysis conditions involved are, not surprisingly, similar to those which we have found preferable. However, the patent limits itself to utilization of active carbon for refinement.

Processing of foods, e.g. natural oils, may involve a deodorization step to improve the product's flavour and odour. This process consists in blowing steam through the oil while it is kept at a high temperature and under high vacuum. We chose the simplest possible adaptation of this procedure: Steam is passed through the hydrolysate while it is kept at the boiling point. Initial investigations indicated that the best effect is attained if neutralization is carried out prior to deodorization, the implication being that part of the off-odours may be of a basic nature.

From Table 2 it is seen that preparation C was ranked as second best while Fig. 1 shows that of the three acceptable preparations, C contained the highest amount of Lowry positive material. Bitterness, as detected in preparation C, is usually ascribed to hydrophobic peptides and humins (Turner, 1961). Indications are, therefore, that the relatively mild hydrolytic conditions applied to sample C are conducive to the formation of such compounds. However, the advantages of employing a relatively low concentration of acid are significant (cheaper; lower salt content in the product), so debittering the hydrolysate is an attractive alternative. Simple filtration is known to reduce the bitter flavour of protein hydrolysates (Turner, 1961), and, presumably, our refinement step involving fractionated dissolution and filtration has an even better effect.

The desired meat-like flavour arises from Maillard reactions between free amino-acids and carbohydrates as well as by other mechanisms such as the Strecker degradation (Raghavan *et al.*, 1976). These complex reactions cannot be directly controlled, so optimization of the process must rely on sensory evaluations of different preparations. The salt content of the

neutralized hydrolysate is, of course, determined by the concentration of hydrochloric acid used, whereas the low heme content is due to its splitting off of iron and degradation of the porphyrin moiety at acid conditions.

At the market place, flavourings made from blood will have to compete with products based on hydrolysis of vegetable proteins. Since it is questionable that blood provides a cheaper and/or more easily processed raw material, the flavourings derived from it must be qualitatively better to become commercially successful. We have reason to believe that the demands regarding sensory properties can be satisfied.

REFERENCES

Fretheim, K. and Gumpen, S.Aa. (1978) Proceedings 24th Eur. Meet. Meat Research Workers, Kulmbach, H9.

Fuhrhop, J.H. and Smith, K.U. (1975) In Porphyrins and Metalloporphyrins (Ed. K.M. Smith) Elsevier (Amst., Ox., N.Y.) 757-869.

Hald-Christensen, V. (1978) Proceedings 24th Eur. Meet. Meat Research Workers, Kulmbach, H5.

Hellqvist, C.-O.H. (1978) Swedish Patent Application no. 396 276, cfr. Food Sci. Technol. Abstr. 10, 4 S459.

Hermansson, A.M. and Tornberg, E. (1976) Proceedings 22th Eur. Meet. Meat Research Workers, Malmö, I1.

Lowry, O.H., Rosebrough, N.J., Farr, A.L. and Randall, R.J. (1951) J. Biol. Chem. 193, 265-275.

Raghavan, B., Shankaranarayana, M.L., Abraham, K.O. and Natarajan, C.P. (1976) Indian Food Packer 30, 22-27.

Stachowicz, K.J., Eriksson, C.E. and Tjelle, S. (1977) ACS Symp. No. 47 on Enzymes in Food and Beverage Processing, 295-303.

Turner, E.W. (1961) U.S. Patent 3.010.829; Described in: Karmas, E. (1975) Fresh Meat Technology, (Noyes Data Corporation, London, England), 93-95.

Tybor, P.T., Dill, C.W. and Landmann, W.A. (1975) J. Food Sci. 40, 155-159.

Wismer-Pedersen, J. (1978) Proceedings 24th Eur. Meet. Meat Research Workers, Kulmbach, H4.