Effect of heat treatment on protein quality and sensory changes in canned food

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Experiments have been carried out to study the effects of different heat treatments of canned meat products on net protein utilization (NPU), sensory changes, and their relations.

Samples of raw liver paste and meat balls were autoclaved at the same temperature as used in conventional processing, but at different length of time resulting in F-values of 1.9, 2.7, 5.6 and 12.3 for liver paste and 2.7, 7.4 and 14.6 for meat balls. The raw products and the commercial products from the same batch were also used in these experiments.

Liver paste autoclaved with F-values of 1.9 and 2.7 had about the same NPU as the raw product (65-66), but samples autoclaved at F=5.6 had significantly lower NPU (62.9). A further decrease in NPU to 58.2 was observed at the F-value of 12.3 which was in the same order as the commercial processed sample. The NPU for meat balls fell from 74.6 (raw product) to 64.9 after commercial processing. The F-values of 2.7, 7.4 and 14.6 resulted in NPU's of 69.7, 67.3 and 62.7, respectively.

For some of the sensory criteria judged, high correlation coefficients were obtained between the reduction in NPU by increased heat treatment and the lowered sensory quality of the products.

Wirkung von Hitzebelastung auf Proteinqualität und sensorische Eigenschaften in konservierten Nahrungsmitteln

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Versuche zur Ermittlung der Wirkung von verschiedenen Hitzebelastungsprogrammen im Autoklavierungsprozess bei der Konservierung von Fleischprodukten auf die netto Eiweissauswertung (NPU), sensorische Eigenschaften und dem Zusammenhang zwischen beiden, sind durchgeführt.

Proben von roher Leberpastete und Fleischklösschen wurden bei gleicher Temperatur autoklaviert wie bei handelsüblicher Erzeugung, jedoch bei unterschiedlichen Zeitabschnitten was in F-Werten von 1,9; 2,7; 5,6 und 12,3 für Leberpastete resultierte und in 2,7; 7,4 und 14,6 für die Fleischklösschen. Die Rohprodukte und handelsübliche Erzeugnisse aus gleicher Produktionsmischung wurden in diesen Versuchen ebenfalls gebraucht.

Autoklavierte Leberpastete die bei der Berechnung einen F-Wert von 1,9 und 2,7 aufwies, hatte ungefähr den gleichen NPU wie das Rohprodukt (65-66), während autoklavierte Proben die F= 5,6 gaben, signifikant niedrigeres NPU aufwiesen (62,9). Eine weitere Reduktion des NPU-Wertes auf 58,2 wurde beim F-Wert von 12,3 beobachtet, was dieselbe Stufe wie das handelsübliche Erzeugnis darstellt.

NPU für Fleischklösschen sank von 74,6 im Rohprodukt auf 64,9 im verkaufsfertigum Produkt. Die F-Werte 2,7; 7,4 und 14,6 resultierten in NPU's von beziehungsweise 69,7; 67,3 und 62,7.

Für einige der sensorischen Kriterien die bewertet sind wurde eine hohe Korrelation zwischen Reduktion in NPU bei gesteigerter Hitzebelastung und geringerer sensorischer Qualität gefunden.

Edellinen sivu tyhjä

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Influence de chauffage sur la qualité de protéine et les changements sensoriaux des aliments hermétiques

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Des expériences ont été faites pour étudier l'influence des traitments différents du chauffage des produits de la viande hermétique sur l'utilisation nette des protéines (NPU), des changements sensoriaux et leurs relations.

Des échantillons de paté de foie cru et de boulettes de viande ont été autoclavés a la même température qu'on utilise dans la méthode courante, mais a une durée différente du traitment thermique, donnant des résultats des F-valeurs de 1.9, 2.7, 5.6 et 12.3 pour le paté de foie et 2.7, 7.4 et 14.6 pour les boulettes de viande. Les produits crus et les produits commerciaux de la même fournée ont aussi été utilisés dans ces expériences.

Le paté de foie autoclavé avec des F-valeurs de 1.9 et de 2.7 avait presque la même NPU que le produit cru (65-66), mais les échantillons autoclavés a F=5,6 avaient significativement une NPU plus basse (62.9). Une réduction davantage de la NPU a été constatée au F-valeur de 12.3, qui a coincidé avec l'échantillon rélévé au cours du procédé commercial. Apres le procédé commercial la NPU des boulettes de viande a diminué de 74.6 (produit cru) jusqu'a 64.9. Les F-valeurs de 2.7, 7.4 et 14.6 ont eu comme résultat une NPU de respectivement 69.7, 67.3 et 62.7.

Pour quelques-unes des caractéristiques sensorielles prouvées, on avait obtenu des coefficients de corrélation hauts entre la réduction de NPU par augmentation de chauffage, et la diminution de la qualité sensorielle des produits.

Влияние тепловой обработки на качество протеина и вкусовые качества герметизированных мясных пищевых продуктов

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Опыт проведен для изучения влияния разных программ тепловой обработки мясных продуктов в автоклаве на усвояемость протеина/нетто-использование протеина -NPU/, вкусовые качества продуктов и связь между ними.

Пробы сырого ливерного паштета и сырых мясных клёцек были подвергнуты нагреванию в автоклаве при тех-же температурах, что и в коммерческом производстве, но в течении разного времени, что привело к получению разных показателей F, равных: для ливерного паштета -1,9; 2,7; 5,6 и 12,3 и для мясных клёцек - 2,7; 7,4 и 14,6.

Сырые пробы и готовые продажные продукты из одной и той-же производственной смеси были также включены в данный опыт.

Ливерный паштет, получивший после нагревания в автоклаве F -показатели 1,9 и 2,7, имел теже самые NPU, как и сырой продукт /65-66/, в то время, как пробы с F =5,6 имели достоверно-пониженную NPU/62,9/. Дальнейшее уменьшение величины NPU до 58,2 наблюдалось при F=12,3 и здесь оно было на том же уровне, как и в торговых продуктах.

Для мясных клёцек NPU снизилось с 74,6 в сыром продукте до 64,9 в готовых продажных консервах. Пробы, имевшие после нагревания показатели F=2,7; 7,4 и 14,6 дали NPU соответственно 69,7; 67,3 и 62,7.

При оценке некоторых вкусовых качеств была найдена относительно высокая положительная корреляция между уменьшением NPU при увеличенной тепловой обработке и понижении вкусовых качеств.

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Introduction

It is well known that nutritional changes occur in proteins during autoclaving (reviewed by Bender, 1978) and that these changes are dependent on heat applied, length of time of processing, presence of carbohydrates and several other factors. It is also known that heat processes generally influence the sensory quality of food (Board et al. 1966, Lyon et al. 1975, Persson et al. 1973) and that a variety of foods have better sensoric and nutritional properties after high temperature, short time sterilization than after conventional sterilization by autoclaving (Reichert 1972). There is however, very little information on the relation of nutritional and sensory quality of the same type of product after different heat treatments. The purpose of this study was therefore to relate changes in biological value (BV), true digestibility (TD) and net protein utilization (NPU) to sensory changes brought about by heat treatment of canned food, using the same temperature as used in the conventional production, but varying length of time in trying to optimize the heat process from nutritional and sensory points.

Material and Methods

Nutritional evaluation of protein quality was conducted on two types of canned food products, namely liver paste and meat balls. The samples were collected from a commercial production unit. Samples from the raw and processed conventional products were collected from the same batch for each of the types of foods, and samples were autoclaved using the same temperature as in the conventional production, but at different length of times resulting in F-values of 1.9, 2.7, 5.6 and 12.3 for liver paste and 2.7, 7.4 and 14.6 for meat balls. The meat balls were deep-fat fried and filled in boxes (425 g net weight with sauce). The liver paste boxes were 100 g each. The raw and commercial products from the same batch were also tested for nutritional quality.

During processing, the temperature of the products was monitored using a fine copper-constantan termocouple embedded in the center of a can, and the output of the termocouple was recorded using a strip chart recorder.

The samples were freeze dried, analyzed for Kjeldahl-N, and diet of 500 g dry matter of each of the products was prepared by mixing the calculated amount to give 150 mg N/10 g dry matter. Each test diet was fed to 5 wistar male rats with average weight of 70±2.0 g. Each rat received 150 mg N in 10 g dry matter daily throughout 9 days, the last 5 days being a balance period. The BV, TD and NPU of the samples were determined by the procedure of Mitchell (1924) as modified by Eggum (1973).

The different products were tested by a sensory panel (12 judges, 3 replicates) by the criteria of characteristic taste, burned taste, off-flavour, firmness, amount of fat liberated, juiciness and total preference.

Results

The BV, TD and NPU data for the different heat processed liver pastes appear in Table 1. BV was reduced from 67.9 to 62.2% by the commercial processing. The TD was not significantly affected, but NPU was reduced 5.7 percent units. Liver paste autoclaved at F-value of 1.9 tended to have higher BV than the raw product, while the product from the F-value of 2.7 had the same BV as the raw liver paste. Heat treatment above this point (F=5.7) resulted in lower BV than the raw liver paste and those autoclaved at F-value of 1.9 and 2.7. The F-value of

Table 1.

Nutritional value of liver paste autoclaved at different F-values compared to the commercial product and the raw product from the same batch.

		True digestibility (%)	Biological value (%)	Net protein utilization (%)
Raw liver paste		96.7±1.0[1]	67.9±1.4	65.6±1.5
Commercial liver paste[2]		96.3±0.4	62.2±1.9	59.9±2.0
Liver paste autoclaved[2]	F=1.9	95.3±1.0	69.0±1.2	65.8±1.5
	F=2.7	96.4±0.8	67.9±2.4	65.5±2.1
	F=5.6	96.6±1.1	65.1±1.2	62.9±1.4
	F=12.3	93.6±1.7	62.1±1.8	58.2±1.7

1) Standard error of the mean
2) Temperature 112°C

Table 2.

Nutritional value of meat balls autoclaved at different F-values compared to deep-fat fried and raw product.

		True digestibility (%)	Biological value (%)	Net protein utilization (%)
Raw meat balls		99.4±1.6	74.9±0.9[1]	74.6±1.7
Deep-fat fried meat balls[2]		97.6±1.6	72.8±1.8	71.1±2.8
Commercial meat balls[3]		92.5±1.1	70.2±1.3	64.9±1.7
Meat balls autoclaved[3]	F=2.7	96.9±0.9	71.9±1.1	69.7±1.0
	F=7.4	95.0±1.0	70.8±1.6	67.3±1.4
	F=14.6	93.0±1.4	67.4±0.9	62.7±1.1

1) Standard error of the mean
2) 10 minutes at 170°C
3) Temperature 118°C

12.3 resulted in a BV in the same range as the commercial processed samples, but the decreased TD resulting in somewhat lower NPU.

The same type of study was conducted with meat balls, but with three autoclaving programs in addition to the commercial, raw and the deep-fat fried product. The nutritional data appear in Table 2. The BV of the commercial product was reduced from 74.9 to 70.2, while the NPU fell from 74.6 to 64.9%. The greater effect here was due to the TD-fall from 99.4 to 92.5% by processing. The different heat treatment times at 118°C resulting in F-values of 2.7, 7.4 and 14.6 gave NPU percentages of 69.7, 67.3 and 62.7 and TD of 96.9, 95.0 and 93.0%.

The relation of some sensory criteria and NPU's appear in Fig. 1 for liver paste and in Fig. 2 for meat balls. Firmness and amount of liberated fat were not significantly affected by the heat treatment programs. Characteristic taste and total preference was significantly reduced by heat treatment programs above F-value of 2.7. The scores for burned taste increased from 1.28 to 2.14. Off-flavour increased somewhat by longer heat treatment time, this effect, however, was not significant. For meat balls (Fig. 2) it appears that when NPU decreases, the burned taste and juiciness increase, while the total preference decreases.

Discussion

The heat treatments applied in the autoclaving processes of the two groups of products influenced the nutritional quality of the protein to a large extent. This is caused by chemical changes taking place (Bjarnason &

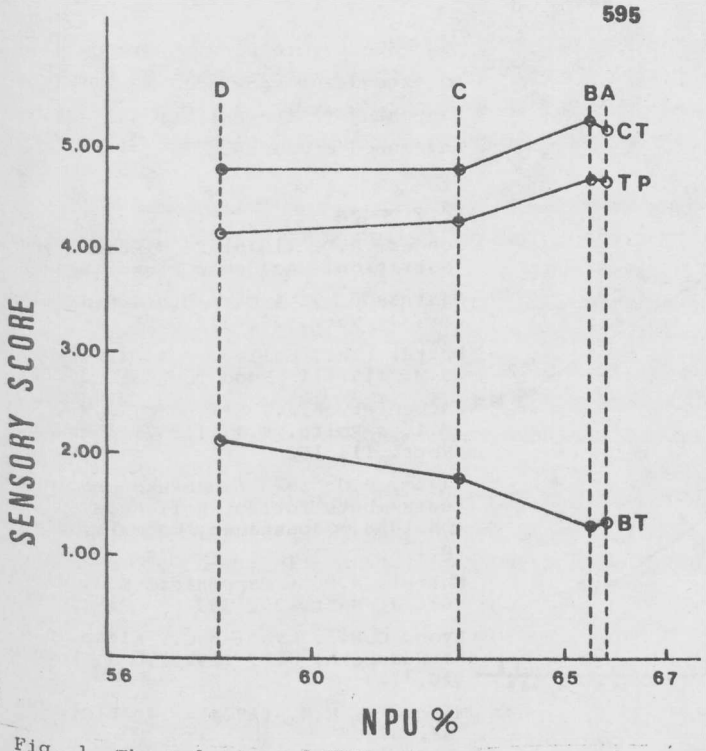

Fig. 1. The relation of NPU and sensory score for liver paste (BT = burned taste, CT = characteristic taste, TP = total preference). A, B, C, D indicate the products autoclaved at F-value of 1.9, 2.7, 5.6 and 12.3, respectively.

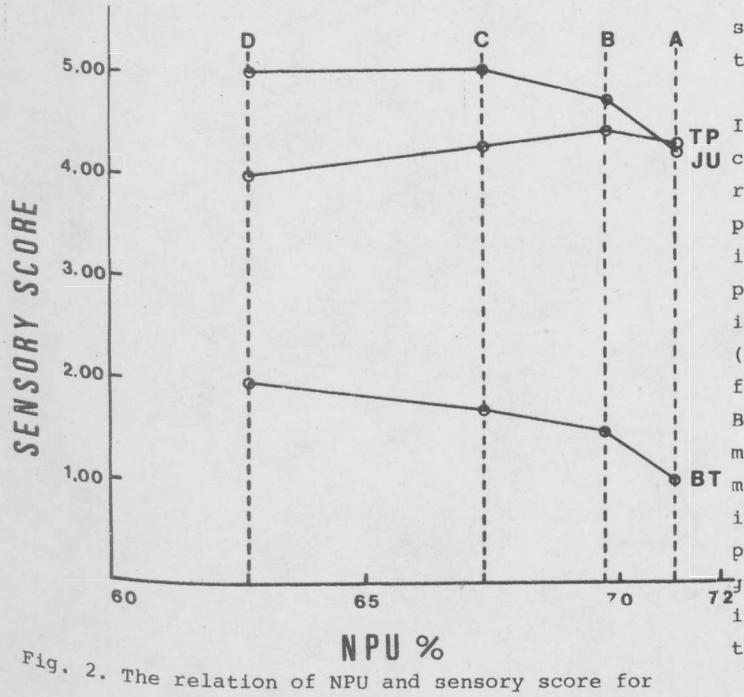

Fig. 2. The relation of NPU and sensory score for meat balls (BT = burned taste, JU = juiciness taste and TP = total preference. A is the deep-fat fried product, B, C and D is autoclaved at F-values of 2.7, 7.4 and 14.6, respectively.

Carpenter, 1970, Osner & Johnsen, 1974, Hurrel & Carpenter 1976). As we in this case knew the temperature at which the commercial products were processed at, and used the same temperatures in our model studies, we plotted the NPU's vs. F-value of the products autoclaved at known F-values. From these curves (Fig. 3) we found the F-values of which the commercial products were autoclaved at were above 10. This heat treatment may be far in excess for strict bacteriological safety.

It was of interest to investigate the changes in nutritional and sensory quality in trying to optimize the autoclaving process. Very few studies have been conducted to look at the relation of nutritional and sensory changes. Carpenter et al. as early as 1957 found that overheated fish products developed "a foul smell and very dark colour" and that the fall in gross protein value was 28%, while previously Regier & Tappel (1956) found loss of sensory quality without a fall in nutritive value.

In our study a positive correlation coefficient of 0.84 was found between reduction in NPU, and lowered total preference by the sensory judgement by increased heat treatment of liver paste. For meat balls, burned taste increased by lowered protein quality (r=-0.83). The correlation coefficient for total preference and NPU was -0.67. Burned taste was the single criteria most affected by increased heat treatment in liver paste (r=-0.92). Our data indicate that within the same batch of product processed by different heat programs, the sensory quality may be used in evaluating the nutritional value of the products.

It can also be concluded that some overcooking of products is practiced in order to ascertain full hygienic safety. This may be regarded undesireable from a nutritional point of view,

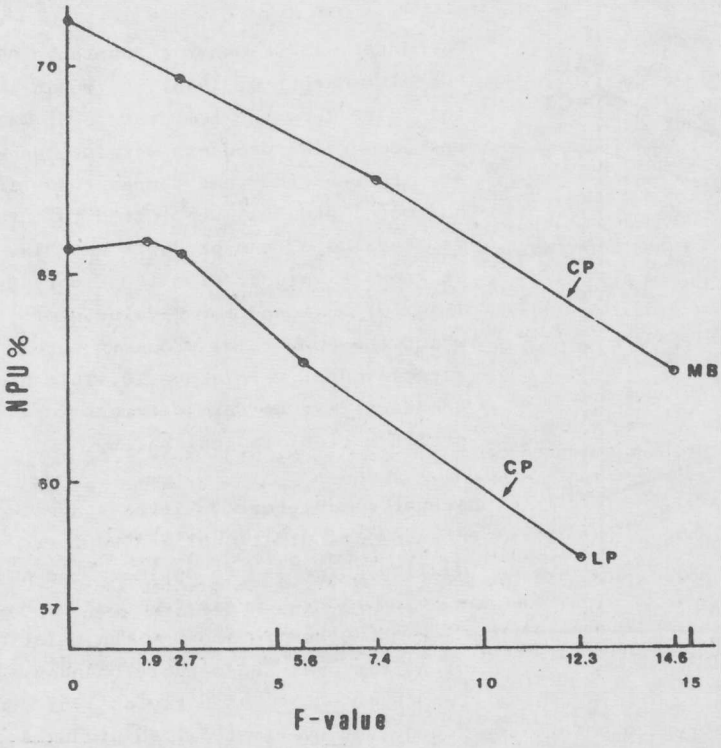

Fig. 3. Relation of NPU and F-value applied for LP (liver paste) and MB (meat balls) during autoclaving. CP = commercial product produced from the same batch.

and more future work should be done to extend our knowledge of what is happening to the nutritional value in canned products.

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