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The use of blood plasma proteins as an additive in cooked meat products.

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ABSTRACT

Two kinds of cooked meat products (Frankfurter sausages and canned Luncheon meat) were made and 10% of meat from the basic recipes substituted by blood plasma proteins. The control series was compared to the series with added plasma proteins. Protein, fat and moisture were determined on all products according to the official methods. On the other hand sensory evaluation and objective shear measurements for all products were performed. Furthermore color measurements (Gardner colorimeter L, a and b scales) were made in the final products. Additionally microbiological examinations for Frankfurter sausages were performed for 7 days of storage.
The chemical composition showed no significant difference among the compared meat products except of the protein content in Frankfurter sausages. Sensory evaluation, color measurements and microbiological analyses did not show significant differences among the final products. The measurements of shear forces showed a statistically significant difference between the two comparing samples of canned Luncheon meat.

INTRODUCTION

Protein isolates prepared from cattle blood collected at the time of slaughter represent a basic source of large quantities of high quality protein. The potential of using plasma proteins in foods such as bakery products and meat products is high due to both economic and functional reasons. Depending upon species, animals will yield an amount of blood during the slaughtering process equal to approximately 7% of body weight on a wet basis and 0,7% on a dry basis (Libby, 1975). Also, animal blood contains about 18% crude protein of which 20% is found in the plasma and as much as 80% in blood corpuscles (Autio et al., 1984).
New protein sources are valued not only for their merit as a nutritional supplements (economic benefit) but also for their effects on the functional properties of various kinds of foods (Inger et al., 1985). Among the functional properties of blood plasma proteins emulsifying properties are basic and of the most importance to their utilization in cooked meat products. Nakamura et al. (1984) reported that emulsifying capacities of plasma proteins were the best among three kinds of proteins (cotton seed, soy and milk proteins).
The purpose of this study was to produce two kinds of cooked meat products (Frankfurter sausages and canned Luncheon meat) where 10% of meat (from basic recipies) substituted by the blood plasma proteins. The chemical composition, sensory evaluation, shear forces and color measurements from both products (with blood plasma proteins, without blood plasma proteins) were examined. Furthermore microbiological examinations for Frankfurter sausages were performed for 7 days of storage (+4°C).

MATERIALS AND METHODS

a. Preparation of blood plasma.

Whole bovine blood was collected at the time of slaughter from a local slaughter house and immediately commingled (9:1/v/v) with 0,85% NaCl solution (Tybor et al., 1975) containing sodium citrate at a level of 0,02% in the mixture. The mixture was maintained at 4°C. Immediately upon arriving at the laboratory the mixture separated into plasma and red cell fractions with a milk separator. The red cell fractions were discarded and the blood plasma was frozen at -22°C until used to the experiments.

b. Production of Frankfurter sausages.

Two series of Frankfurter sausages were produced, one with 10% blood plasma proteins and one without blood plasma according to the following basic formulation: lean pork meat 40%, pork fat 30%, water (ice) 30%, starch 3%, salt 1,5%, sodium caseinate 2%, sodium nitrite 120 ppm and 0,5% seasonings. The lean meat was placed in a Silent Cutter and chopped for 3 min at high speed being careful to keep the paste below 15°C. At this point, the remaining ingredients were added and the mix was chopped at high speed for an additional 12 min. The resulting paste was transfered to a chilled piston driven hand stuffer and immediately stuffed into 24 mm Naturin casings and linked every 12 cm. The links were allowed to stand at room temperature for 1 h and then were cooked under industrial conditions. The core temperature was 78°C for 10 min (Stiebing, 1985). The processed links after cooking cooled until an internal temperature of 30°C or lower was reached. The links were hung and cooled in a 2 °C cooler overnight and then vacuum packed and stored at 4°C for 7 days.

c. Production of canned Luncheon meat.

Two series of canned Luncheon meat were produced, one with 10% blood plasma proteins and the other without plasma proteins. The basic batter of canned Luncheon meat contained: pork meat 66,3%, pork fat 20%, water (ice) 12%, sodium nitrite 120 ppm, sodium ascorbate 0,1%, sugar 0,2%, sodium caseinate 2%, sodium tripolyphosphate 0,2%, salt 1,6% and 0,3% seasonings. The pork meat was placed in a grinder and was ground through a 1/8 inch plate one time. The chopped meat and the other ingredients were mixed and chopped again in a Silent cutter for 8 min. The resulting batter was transfered to a chilled piston driven hand stuffer and immediately stuffed into tin cans. The cans were sealed and sterilized. Heat penatration measurements were performed for every type (with and without blood plasma proteins) of canned Luncheon meat. A German "Labor Rotorzwerg" constructed an agitating retort for pressure processing with water as a heating medium was used. The retort is equipped with thermocouples and an automatic petentiometric recorder. It is also included a Fo-value computer type Z9-CTF from ELLAB, Denmark. The thermocouples were placed in the core of the cans and the temperature curves were automatically registered and calculated.

d. Chemical analyses.

Protein, fat and moisture were determined in all products according to the official methods (AOAC, 1975).

e. Color and shear forces measurements.

Samples of both products (Frankfurter sausages and Luncheon meat) were measured for color differences with a Gardner Colorimeter (L,a and b scales). Preliminary studies included determination of infinite sample thickness to ensure no transmission of light through the sample. This was determined to be 12 mm. Samples were cut to fit a cuvette appropriate for the colorimeter and were placed side by side in the cuvette so that the curved surface of the sample either upper and deep would be towards the instrument anerture. A second layer of sample was placed over the first in a similar fashion to block transmission of light through the area adjacent to two slices of samples. Color measurements made on samples with and without blood plasma proteins were done in a similar manner.

Shear force values were determined with a Warner-Bratzler shearing device (Model 2000) equipped with a 10kg dynamometer. Each test day, two samples of every kind of product were sheared six times each.

f. Sensory evaluation.

The sensory panel consisted of 10 members who are staff of the Food Hygiene and Food Technology laboratories. Several training sessions were given to the panelists before initiation of the experiment. Three samples were given to the panelists. Two numbered samples and a reference. One of the numbered samples was identical to the reference. Panelists were instructed to indicate which of the numbered samples was identical to the reference (in term of tasty).

g. Microbiological analyses.

On the Frankfurter samples (with and without blood plasma) the following microbiological analyses were performed: aerobic mesophiles, coliforms, sulfite reducing clostridia, yeasts and molds and psychrotrophes in the 1st, 3rd, 5th and 7th day of storage at 4°C.

1. Aerobic mesophiles - Portion of approximately 50 g were taken from each day's pack and was sampled for bacterial loading. Pour plate count method was used. Standard-1 agar in duplicate series was used for total counts. The plates were incubated at 32°C for three days, then counted according to APHA (1976).

2. Coliforms - The MPN (Most Probable Number) method of enumeration was used for determining the numbers of coliforms. MacConkey broth was used and the tubes were incubated at 32°C for 48 h.

3. Sulfite reducing clostridia - Pour plate count method was used for enumeration sulfite reducing clostridia. The total population was determined in SPS agar. Plates were counted after 48 h of incubation at 37°C in a Gas-Pak system.

4. Yeasts and molds - Spread plate method was used to determine yeasts and molds. Rose-Bengal Chloramphenicol Agar was used and the plates incubated at 25°C for 5 days, then counted according to APHA (1976).

5. Psychrotrophic bacteria - Standard-1 agar was employed for the psychrotrophic count. The plates were incubated at 7°C for 10 days.

RESULTS AND DISCUSSION

The sterilization data of canned Luncheon meat are shown in table 1. The determination of thermal processes which should be applied to foods in containers in order to render the food "commercially sterile" has undergone considerable development in the last 50 years. The basic objective of the calculation has been to establish the time at the retort temperature which will result to maintain one degree of quality factors in the food. Today we have dropped the use of Fo-values for a sufficient sterilization (Skramstad, 1977, Vareltzis et al., 1985).

The chemical composition of the Frankfurter sausages and the canned Luncheon meat are shown in tables 2 and 3. The significantly higher protein level in the Frankfurter sausages with blood plasma proteins proved that blood plasma proteins can enhance the nutritive value of meat products. Furthermore, the results of chemical composition of all products showed that the blood plasma proteins at a level of 10% can be used successfully in the cooked meat products manufacture.

TABLE 1. Sterilization data (canned Luncheon meat).

Initial food temperature	:	15°C
Come up time	:	40 min
Holding time	:	26 min
Sterilization temperature	:	117°C
Cooling time	:	25 min
Total heat processing time	:	66 min
Rotation	:	30 rpm
F_o value	:	5,94 min

TABLE 2. Chemical composition of Frankfurter sausages.

%		$\bar{x}$	s^2	s	max.	min.
Moisture	A	57,649	0,237	0,486	58,659	56,662
	B	58,224	1,773	1,331	59,797	55,511
Fat	A	29,184	2,758	1,660	31,671	26,046
	B	28,362	3,725	1,930	31,865	26,155
Proteins	A	10,582*	0,423	0,650	11,581	9,033
	B	11,280*	0,970	0,985	12,907	9,956

A = samples without blood plasma proteins
B = samples with blood plasma proteins
* means that it is significantly different at level 0,05

TABLE 3. Chemical composition of canned Luncheon meat.

%		$\bar{x}$	s^2	s	max.	min.
Moisture	A	57,373	0,619	0,787	59,119	56,183
	B	57,705	1,174	1,083	59,121	55,158
Fat	A	25,837	0,914	0,956	27,931	24,128
	B	25,343	1,995	1,412	28,489	23,114
Proteins	A	16,083	0,666	0,816	17,121	13,588
	B	16,311	1,068	1,033	17,931	14,031

A = samples without blood plasma proteins
B = samples with blood plasma proteins

Average Gardner color reflectance values for final products are shown in table 4. Table 4 showes very cleary that the hue of the surfaces of blood plasma proteins containing franks and canned Luncheon meat is almost the same with the reference samples (without blood plasma proteins). There is not significant difference at the 0,05 level for L, a, b and a/b values. These results mean that the use of blood plasma in the production of cooked meat products did not affect the appearance of products.

The objective shear values of Frankfurter sausages and canned Luncheon meat are shown in table 5. Shear forces were determined to see if the blood plasma proteins caused any textural changes in the products. Average forces required to shear the canned Luncheon meat samples were significantly defferent at the 0,05 level.

Young (1980) reported that plasma proteins have unusual gelation characteristics and high emulsification capacity. The capacity of plasma proteins to bind a certain amount of water is advantageous for meat products.

TABLE 4. Average Gardner reflectance values* for Frankfurter sausages and canned Luncheon meat.

		Frankfurter sausages				Canned Luncheon meat		
		L	a	b		L	a	b
A	$\bar{x}$	55,820	9,900	10,650	$\bar{x}$	43,872	18,992	9,456
	s^2	8,396	2,075	0,815	s^2	4,976	0,898	0,875
	s	2,897	1,440	0,902	s	2,230	0,947	0,935
B	$\bar{x}$	56,155	10,075	10,610	$\bar{x}$	45,080	18,816	9,792
	s^2	8,452	1,805	1,000	s^2	3,907	0,488	1,180
	s	2,907	1,343	1,000	s	1,976	0,699	1,086

A = samples without blood plasma proteins
B = samples with blood plasma proteins
* average of six observations

Of equal importance in food systems is the reaction of the supplemented proteins to heat treatment. Heat gelation of the plasma proteins is generally advantageous, since the stable three dimensional network formed can absorb water, fat and other components as well as producing desirable textural characteristics (Hermansson, 1982).

The results of the sensory evaluation are shown in tables 6 and 7. There was apparently little difference in tasty among the samples, since panelists were unable to consistently identify a statistically significant number of samples as being identical to the reference samples.

The results of microbiological analyses are shown in table 8. The action which expressed as a difference of the number of bacteria that existed in the reference samples (Frankfurter sausages without blood plasma proteins) and of those in the treated samples (Frankfurter sausages with blood plasma proteins) was found to be not statistically significant at 0,05 level for the aerobic mesophiles, coliforms and psychrotrophes. Sulfite reducing clostridia, yeasts and molds were not detected for seven days of storage.

In conclusion the use of blood plasma proteins in the production of cooked meat products is feasible. On the other hand abattoir by-products such as blood which is a proteinaceous material must be accepted by human consumers. If the new products are clean, palatable and nutritionally usefull could be used as human food. Unfortunately the present situation in our country seems to be that legislators are defining certain materials as non-meat but they are not providing adequate methods by which these materials could be regulated.

TABLE 5. Objective shear values* of Frankfurter sausages and canned Luncheon meat.

		$\bar{x}$	s^2	s	max.	min.
Frankfurter saus.	A	0,256	0,004	0,066	0,45	0,15
	B	0,236	0,001	0,033	0,30	0,20
Luncheon meat	A	0,514**	0,017	0,131	0,77	0,35
	B	0,443**	0,005	0,072	0,60	0,25

A = samples without blood plasma proteins.
B = samples with blood plasma proteins.
* average of six observations.
** means that it is significantly different at level 0,05

TABLE 6. Number of sensory panelists correctly identifying a numbered sample of Frankfurter sausages as being identical to the reference sample.

Trial	Number of tests	Number of correct identifications by panelists	Number of correct identifications required for significance at 0,05 level
I	10	3	7
II	9	0	6
III	8	2	6
IV	8	1	6
V	7	1	5
VI	7	0	5
VII	8	5	6
VIII	7	2	5

TABLE 7. Number of sensory panelists correctly identifying a numbered sample of canned Luncheon meat as being identical to the reference sample.

Trial	Number of tests	Number of correct identifications by panelists	Number of correct identifications required for significance at 0,05 level
I	10	6	7
II	9	1	6
III	10	0	7
IV	8	3	6
V	9	5	6
VI	9	2	6
VII	8	0	6

TABLE 8. Results of microbiological analyses of Frankfurter sausages in vacuum packed stored at 4°C for 7 days.

		DAYS 1 $\bar{x}$	3 $\bar{x}$	5 $\bar{x}$	7 $\bar{x}$
Mesophiles	A	$2x10^3$	$5,8x10^3$	$7,5x10^3$	$1,1x10^4$
	B	$4x10^3$	$4,2x10^3$	$4,7x10^3$	$8,6x10^3$
Coliforms	A	<10	< 10	< 10	< 10
	B	<10	< 10	< 10	< 10
Sulfite reducing clostridia	A	-	-	-	-
	B	-	-	-	-
Yeasts and molds	A	-	-	-	-
	B	-	-	-	-
Psychrotrophes	A	< 10	< 10	$1,1x10^3$	$1x10^4$
	B	< 10	< 10	$1x10^3$	$9,8x10^3$

A = samples without blood plasma proteins
B = samples with blood plasma proteins

This research consists a part of a project for the utilization of whole blood from slaughter animals, with a cooperation by the Federal Meat Research Institute, Kulmbach, West Germany and Volks-Wagen Stiftung financially supported this project.

REFERENCES

1. American Public Health Association, 1976. Compendium of methods for the microbiological examination of foods. (M.L. Marth ed.) APHA, Washington D.C.
2. Autio, K., M. Kiesvaara, Y. Malkki and S.Kanko, 1984. Chemical and Functional Properties of Blood Globin Prepared by a New Method. J.of Fd. Sci. 49:859-862.
3. Hermansson, A.M. 1982. Gel Characteristics - Structure as Related to Texture and Water Binding of Blood Plasma Gels. J. of Fd. Sci. 47:1965-1972.
4. Horwitz, W. (ed.) 1975. Official methods of analysis. 12th ed. Assoc. Off. Anal. Chem., Washington, D.C.
5. Inger, M. and E. Slinde, 1985. Color, Pigment and Iron Content of Meat Loaves with Blood, Blood Emulsion, or Mechanically Deboned Meat Added. J. of Fd. Sci. 50:1551-1555.
6. Libby, S.A. 1975. Meat Hygiene. 4th ed. Lea and Febigar. Philadelphia.
7. Nakamura, R., S.Haykawa, K. Yasuda and Y. Sato, 1984. Emulsifying Properties of Bovine Blood Globin:A Comparison with Some Proteins and their Improvement. J. of Fd. Sci. 49:102-104.
8. Skramstad, K.H. 1977. Fish Products-Heat Penetration. In "Physical, Chemical and Biological Changes in Food Caused by Thermal Processing". Ed. by Tore Høyem and Oskar Kvale. Applied Science Publishers Ltd.London.
9. Stiebing, A. 1985. Frankfurter-type sausages. Heat treatment and shelf-life. Fleischwirthsch.65:1087-1091.
10. Stiebing, A. 1985. Blutplasma - Gewinnung, Zusammensetzung, Lagerfähigkeit und technologische Wirkung bei Brühwurst. Diplom-Ingenieur. Berlin.

11. Tybor, P.T., C.W. Dill and W.A. Landmann, 1975. Functional properties of proteins isolated from bovine blood by a continuous pilot process. J. of Fd. Sci. 40:155-159.
12. Vareltzis, K., J. Tsiaras and F. Zetou, 1985. A procedure for estimating sterilization of two types of canned fish (Mackerel-Scomber scombrus). A. Fish in oil. B. Fish in tomato sauce. Proceedings of the 1st Greek Congress on Foods. May 1985. Thessaloniki.
13. Young, R.H. 1980. Upgrading of abattoir waste protein. In "Developments in Meat Science-1". Ed. by R.Lawrie. Applied Science Publishers Ltd. London.