Utilization of blood plasma in certain meat products

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Introduction

As a consequence of the growing demand for proteins, the possibility of the utilization of various potential protein sources for human nutrition has been studied very intensively in the recent years. Slaughter animal blood represents a considerable source of good quality protein which is poorly utilized for human consumption in Hungary. The application of whole blood is seriously hampered by its strong colour. Although several attempts have been made for its decolourization /e.g. 1-3/ the problem has not yet been solved. Considerably better results have been obtained by the application of blood plasma, either coagulated /4, 5/ or transformed into a fibrous meat analogue having an attractive appearance /6,,7/. The objective of our work was the investigation of the chemical and nutritive properties of texturated blood plasma and those of certain meat products prepared by its application. As the preparation of blood plasma texturate involves alkaline treatment, we found it necessary to investigate the effects of this treatment on the amino acid composition i.e. the decomposition of certain essential amino acids, which results in the decrease of the biological value of the protein and on the other hand the formation of potentially toxic amino acid derivatives, namely lysinoalanine, which has been demonstrated to be nephrotoxic to certain rodents /8, 9/.

Materials and Methods

Preparation of blood plasma protein texturate

The preparation of blood plasma fibres was essentially similar to the basic method of YOUNG and LOWRIE /6/. Blood plasma /containing sodium-citrate against coagulation/ was concentrated by crioconcentration to approximately 13% /w/v/ protein. The concentrate was diluted by native plasma to a final protein concentration of 9,6%. The cooled /4°C/ plasma was treated with 40% /w/v/ NaOH /32 cm^3/liter/ and allowed to stand for 30 minutes. After this the mixture was extruded to a coagulating bath through a PTFE spinnaret /30 holes, 0,8 mm diameter/. This relatively large diameter was used because the product was intended to be mixed into the emulsion of various sausages. The coagulating bath contained acetic acid /5% v/v/ and sodium chloride /20% w/v/. In order to complete coagulation within the fibres, they were allowed to stand in the coagulating bath for 1 hour, then they were washed in tunning tap water for 1 hour. The fibres were stored in a refrigerator /4°C/ under water or in a freezer /-25°C/. No deterioration was detected for 2 months. The samples were analyzed for moisture, protein content, residual salt and acetic acid content, amino acid composition and lysinoalanine.

Model experiments with blood plasma

In order to obtain data on the susceptibility of blood plasma to lysinoalanine formation and the effects of alkali on the amino acids blood plasma was treated in model experiments with NaOH for 2 and 24 hours at 4°C and 20°C using the same concentration as during the manufacture of the protein fibres. The samples were analyzed for amino acids and lysinoalanine.

eparation of the sausage samples

ur typical types of Hungarian sausages were prepared on a pilot-plant scale /see Table 1/ periser, a frankfurter-type fresh "red" sausage, which is consumed raw, two types of iverwurst /liver sausage/ and Gubacsi sausage, which contains pieces of meat in an emul- on. The sausages were prepared according to standard procedures, the components substi- ted in the experiments by blood plasma protein are shown in Table 1. The sausage samp- es were analyzed for moisture, crude protein, amino acid composition and lysinoalanine. ey were also tested by a sensory panel for appearence, odour, taste, texture and overall pression.

ethods of analysis

rotein was determined by the micro-Kjeldahl method. Amino acids were determined by the tandard methods of our laboratory /10/ using an automatic amino acid analyzer type A 881. Cystein was determined as cysteic acid. Tryptophane was determined colorimetri- lly. Lysinoalanine was also determined by the amino acid analyzer /11/. Digestibility as determined according to HSU /12/. Results are expressed as relative digestibility va- es /casein=100/. Sodium chloride was determined as chloride, using potentiometric itration. Acetic acid was determined after steam distillation.

esults and discussion

able 2 shows the most important chemical characteristics of blood plasma and of the plas- protein fibres. The fibres have a higher protein content than the original plasma, ractically they are pure protein. Because of the colloidal gel structure the fibres tend o swell or shrink if the storage conditions are changed /ionic strength, temperature c/; during ageing they tend to loose water. During the washing the residues of the oagulating bath are practically dialysed from the fibres. The amino acid composition of he fibres is essentially similar to that of the original plasma. The slight differences re due to protein losses during precipitation and washing, and to the alkaline treatment. s compared to the FAO reference protein /13/, blood plasma is relatively rich in lysine, reonine and aromatic amino acids, on the other hand it contains low amounts of methi- nine and iso-leucine. That is why the predictive biological value, calculated according o MORUP and OLESEN /14/ is relatively low, as compared to meats /P.V. = 70 - 100/. These ata on the amino acid composition are close to those of ZHARINOV and co-workers /4, 5/. he amino acid composition indicates that blood plasma protein could be used advantage- usly in combination with other proteins poor in lysine and aromatic amino acids. A syste- atic study on the utilisation of blood plasma protein in a broad spectrum of meat pro- ucts, using computer optimalisation on the basis of in vitro biological value is being repared by the authors presently and will be presented in a following publication. ccording to the results of the model experiments /see Table 3/ blood plasma is fairly ensitive to alkali. This is clearly demonstrated by the decomposition of threonine and ysine, the reduction in the amount of lysine and the formation of lysinoalanine. On the ther hand, arginine is affected only at prolonged treatment. Although in the model xperiments the formation of lysinoalanine was very strong, the plasma protein concentra- s contained only a relatively low amount of this amino acid derivate. It is probable that ertain protein fractions having a high lysinoalanine content do not undergo precipitation r are dissoloved in the coagulating bath. Unfortunately the results of the lysinoalanine nalyses were obtained with a certain delay and the effect could not be investigated, so he explanation of this apparent contradiction requires further research. The chemical omposition of the experimental sausages is shown in Table 4. The addition of blood plasma rotein slightly decreased the protein content of the products and increased the water ontent. According to the data of amino acid composition and predictive biological value

the use of blood plasma additives is not recommended in case of frakfurter type sausages, on the other hand in liver sausages with a high fat content plasma protein could be used advantegeously because it increases the biological value. This effect is especially marked in case of the leberwurst samples. The original biological value of Gubacsi sausage is very good, and the addition of blood plasma does not seem to reduce this high value. The organoleptic properties of the sausages were appropriate. Although the 18 panel members could find the difference in most cases between control and test samples in triangle tests, the properties of the latter were not found either better or worse by statistical methods, with the exception of Gubacsi sausage, where the panel members agreed that the blood plasma addition improved the general appearence of the product. Originally, we wanted to find out whether the addition of plasma protein might be detected by the analysis of lysinoalanine of the products, however, the original lysinoalanine content of the products was found surprisingly high. In most cases the addition of plasma protein increased the original value, but the original lysinoalanine content of gubacsi sausage is so high that it is decreased by the addition of blood plasma protein. This also points to the necessitity of a systematic screening test of meat products until the question of human toxicity of lysinoalanine is elucidated.

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table I

Experimental sausage samples

sign	sausage type	plasma protein %	substituted components
P - 0	pariser	0	----
P - 5	pariser	5	bovine meat
L - 0	leberwurst	0	----
L - 5	leberwurst	5	porcine stomach, boiled pork
L -15	leberwurst	15	stomach, boiled pork, liver, bacon
PL- 0	paprika-leberwurst	0	----
PL- 5	paprika-leberwurst	5	porcine liver
PL-15	paprika-leberwurst	15	porcine liver, boiled pork
G - 0	"Gubacsi" sausage	0	----
G - 5	"Gubacsi" sausage	5	porcine liver, boiled pork
G -15	"Gubacsi" sausage	15	porcine liver, boiled pork, skin

Chemical composition of blood plasma and plasma protein texturates

table II

	essential amino acids										LAL	Predictive Biological
	THR	CYS	VAL	MET	ILE	LEU	TYR	PHE	LYS	TRP		
	g amino acid / 100 g protein										ppm	Value
Blood plasma /concentrated/	6.62	1.99	6.24	1.83	3.09	7.60	4.98	5.00	8.45	1.05	0	46.1
Protein texturate unwashed	6.25	1.74	6.77	1.75	3.28	8.57	4.61	4.76	8.49	0.89	140	40.8
Protein texturate washed	6.64	1.99	6.1	1.67	2.78	8.56	5.20	5.07	8.45	1.01	130	43.1

	dry matter %	protein %	salt /NaCl/ %	acetic acid %	Relative digestibility
Blood plazma /concentrated/	10.5	9.13	1.16	-	92.1
Protein textu-rate unwashed	29.9	21.36	8.54	4.49	98.7
Protein texturate washed	13.9	13.47	0.26	0.12	100.0

table III

Effect of alkaline treatment on blood plasma

Treatment	amino acids g/100 g protein					
	THR	SER	CYS	LYS	ARG	LAL
native plasma /concentrated/	6.62	6.29	1.99	8.65	5.79	0
4°C 2 hrs	6.31	6.15	1.62	8.81	5.81	1.27
4°C 24 hrs	5.51	5.48	1.38	8.07	5.65	2.02
20°C 2 hrs	6.61	6.06	1.35	7.96	5.45	1.52
20°C 24 hrs	4.21	5.25	0.99	6.90	3.36	3.06

table IV

Chemical composition of the experimental sausage samples

	dry matter %	protein	essential amino acids g/100 g protein										Relative digestibility	Predictive Biological Value	LAL ppm
			THR	CYS	VAL	MET	ILE	LEU	TYR	PHE	LYS	TRP			
P - 0	36.4	11.3	5.23	1.85	4.96	3.15	5.19	8.16	3.05	3.89	8.56	1.06	103.7	85.6	130
P - 5	35.7	10.5	6.19	1.74	5.51	2.6	4.72	7.35	3.86	4.45	8.37	1.07	103.4	69.1	140
L - 0	47.3	17.8	7.48	1.68	4.88	2.1	3.72	6.77	2.84	4.07	6.88	1.14	102.8	36.6	410
L - 5	47.9	17.0	7.51	1.81	3.86	2.64	4.79	7.09	4.2	4.98	6.72	1.37	109.0	38.5	430
L -15	43.2	16.9	5.68	2.15	5.15	2.71	3.72	8.42	4.14	5.07	7.23	1.28	97.6	70.3	490
PL- 0	46.7	20.0	5.8	1.27	5.69	2.43	4.48	7.33	3.3	4.18	7.58	1.1	111.3	57.7	310
PL- 5	47.5	16.5	5.48	1.51	4.69	2.61	4.67	7.61	3.9	4.89	7.94	1.38	104.4	75.5	320
PL-15	50.2	15.3	7.18	2.05	5.17	2.19	4.53	7.18	3.1	4.23	6.96	1.43	104.7	44.4	440
G - 0	47.8	18.8	4.33	1.36	4.89	2.58	3.78	7.27	3.14	4.28	6.46	1.1	109.0	99.6	1130
G - 5	48.9	18.1	3.74	1.59	3.6	2.44	3.61	6.88	3.18	4.12	6.55	0.83	120.9	100.2	1140
G -15	45.3	17.8	4.03	1.63	4.57	2.3	3.8	7.09	3.07	4.04	5.65	0.7	117.8	90.0	1070