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EFFECT OF DRYING METHOD ON SELECTED PROPERTIES OF BLOOD PLASMA PREPARATIONS

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The aim of this study was the estimation of properties of bovine blood plasma preparations obtained by spray-, drum- and freeze-drying. Various contents of protein and lipids as well as of tryptophan were found in the examined preparations. Spray- and freeze-dried plasma demonstrated high solubility (> 90%) and emulsifying capacity. The drum-dried plasma demonstrated good sorption properties (water and fat binding). The enzymatic (pepsin + tripsin) digestibility of examined preparations varied between 90% for drum-dried plasma (with starch added) to 97.3% for spray-dried plasma.

INTRODUCTION

The use of blood plasma in manufacture of sausages and canned meat is nowdays the principal way of blood protein application to food products. Blood plasma proteins demonstrate, among others, very good fat emulsifying properties and a capasity of gelated structure formation [1, 3]. On the other hand, the liquid blood plasma exhibits two important negative features, namely: a higher water content combined with low protein content (about 7%). These features decrease the the storage-life of this raw material and limit its applicability to food products [5, 9].

To expand the usage of blood plasma it is recommended to employ: low temperatures, thermal or chemical coagulation, various drying techniques [4, 10, 11]. The initial concentation of plasma protein, e.g. by ultrafiltration technique is also reported [2].

In the commercial practice, apart from fresh-chilled, or frozen plasma also preparations obtained by spray-drying or vacum drum-drying techniques are in current use. These preparations demonstrate diverse chemical composition and varius physical, functional and nutritional properties [6, 8, 12].

However, studies concerning dried blood plasma preparations are of fragmentary nature and difficult to compare due to differences in the methods employed by the autors.

The purpose of this paper was to study the effect of drying technique on certain properties of blood plasma preparations.

MATERIALS AND METHODS

Investigations were carried out on fresh bovine blod plasma of grade, obtained from typical blood processing line, in industrial conditions. Dry plasma samples were prepared from the initial material using the following drying techniques:

a) SPRAY-DRYING

Spray-drying was carried out in an Anhydro drier of Danish manufacture, at inlet and outlet temperature 200° and 80°C, respectively.The speed of the spray disc 7500 r.p.m. was used. The dried sample was in the form of a ligh-brown powder (code of sample: A).

b) DRUM DRYING

The drum drier of Gouda Holland NV Mashinefabrik (type: CL 2617) was used. Drying conditions were as follows:

Code of sample	Temperature of drum (°C)	Drum rotations (r.p.m.)	Starch additive (%)
B	165	7.5	0
C	165	6.0	2

The preparations were in form of dry, crumbled film of light yellow color. The dry plasma preparation with added potato starch demonstrated a lighter color.

c) FREEZE DRYING

Drying process was carried out on commercial freeze-drier of Dutch manufacture. The final product (light brown powder, code of sample: D) was prepared at sublimation temperature −28°C. The total time of drying was about 8 hr.

The following properties were taken to check the most important characteristics of all preparations:

— chemical composition: lipids, protein, and tryptophan content,

— functional properties: solubility of preparation, emulsifying capacity, gel forming ability, swelling and fat absorption,

— enzymatic digestibility ("in vitro").

All the above methods were described earlier by the authors of this publication [12, 13].

All investigations were carried out at least in 3 series.The statistical analisis of experimental results was used [7].

RESULTS AND DISCUSSION

Basic composition of fresh blood plasma in the experiment is shown in Table 1. These results correspond to the ones cited in the literature [2, 6, 9].

Table 1. Composition of fresh bovine blood plasma (mean values)

Compound	Results
Water (%)	91.15
Crude protein (N × 6.25) (%)	6.85
Lipids (%)	0.12
Tryptophan (% of protein)	0.80

Table 2 summarizes the experimental results of determination of main chemical compounds of all investigated dry preparations.

The examined material demonstrates, as expected, diverse protein and lipids content. The highest protein content was found in the case of freeze dried preparation D. The obtained results are correlated with the level of water removed during the process of drying. It seems to result from the intensity of heating and destruction of protein. The least protein and lupids content in the preparation C resulted also from the starch additive.

The next studied compound was tryptophan, a thermolabile compound which may be used as one of indicators of destructive changes in proteins, caused by elevated temperature [5]. In the freeze dried samples the tryptophan content was always higher than in the spray- and drum dried preparations. This points to

Table 2. Content of main compounds in the blood plasma preparations dried with different methods

Code of preparation	Content of main compounds:		
	crude protein lipids		tryptophan (% of protein)
	(% of dry m.)	(% of dry m.)	
A	79.3 (a)	0.55 (a)	0.60 (a)
B	77.4 (a)	0.55 (a)	0.59 (a)
C	54.7 (a)	0.41 (b)	0.60 (a)
D	82.8 (c)	0.54 (a)	0.78 (a)

Note: identical letters within the columns — lack of significant difference at P = 0.05

A — spray-dried plasma preparation

B — drum-dried plasma preparation (free of starch)

C — drum-dried plasma preparation (with 2% of starch added)

D — freeze-dried plasma preparation

freeze drying as a drying method of little effect on the protein fraction of blood plasma. The drum-dired and spray-dried preparations demonstrated lower but the similar tryptophan contents.

Results of determination of certain basic functional properties are given in Table 3. One of them is the solubility of preparation. The spray-dried plasma preparation and freeze-dried are on the top in this respect. It refers particulary to their solubility in 2-percent NaCl solution. The experimental findings indicate that the solubility of drum-dried preparation is regardless of the starch additive, very low both in water nad in the NaCl solution.

Table 3. Some functional properties of blood plasma preparations dried with different methods

Code of preparation	Estimated criterion				
	solubility of preparation (%)		fat absorption (%)	emulsifying capacity ml oil/100 mg of protein	
	in H_2O	in 2% NaCl		in H_2O	in 2% NaCl
A	88.50 (a)	95.50 (a)	300.0 (a)	50.0 (a)	69.3 (a)
B	2.75 (b)	5.63 (b)	310.0 (a)	6.5 (b)	8.3 (b)
C	3.80 (b)	4.63 (b)	360.0 (b)	5.3 (b)	6.5 (b)
D	92.75 (c)	91.25 (a)	320.0 (a)	55.0 (c)	70.0 (a)

Note: see Table 2
A, B, C, D — see Table 2

Both the spray-dried and the freeze-dried preparations demonstrate also a good emulsifying capacity, contrary to the drum-dried preparations which showed very low values of that characteristic. Simultaneously an appreciable, positive effect of the NaCl concentration in the solution on the emulsifying capacity was noted. That observed differences resulted from changes of ionic strengh, which affected the structure and functionality of proteins in examined solutions [12].

The fat binding properties by plasma preparation protein are significant from the technological point of view. The best fat absorption was found in preparation C with potato starch added and drum dried however the differences between that and the other findings were statistically not significant, and they do not allow to associate that characteristic with the plasma drying technique applied.

The swelling ability of the drum-dried plasma preparation was the next characteristic examined. The results are illustrated in Fig. 1. The results point to a significant effect of NaCl concentration (like in the case of other, mentioned above properties), on the swelling ability of the preparations. Also, the starch additive improved this characterictic of plasma preparation, since the preparation C (with starch additive) demonstrated better swelling than that without starch added (preparation B). It is assumable that starch and blood proteins are bound in one large network. It makes the protein dissolving and its removing from this structure more difficult by solutions containing more NaCl.

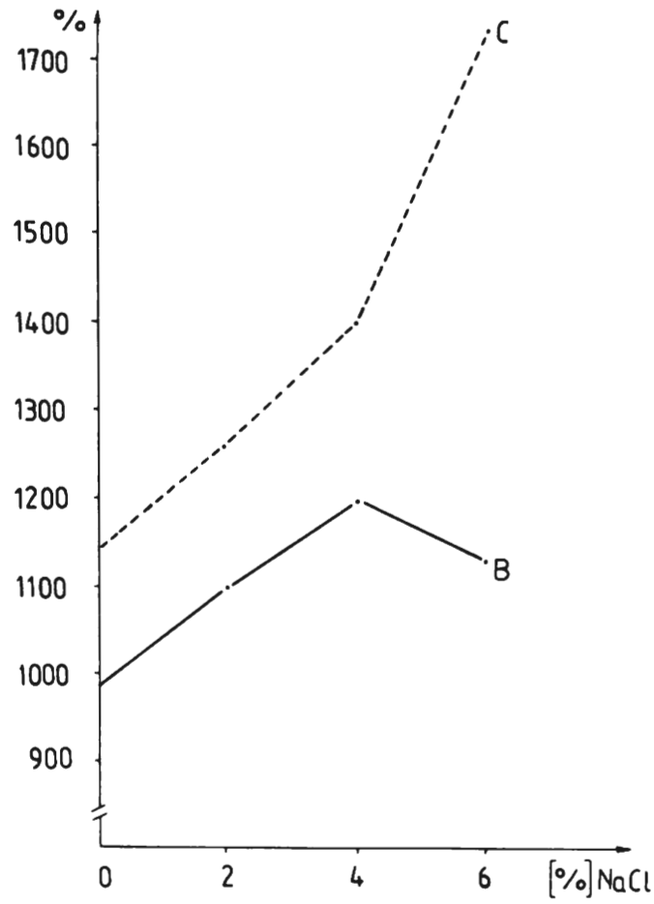

Fig. 1. Sweling of the drum-dried plasma preparations; (description of B, C — see Table 2)

The ability of gelated structure formation by the plasma preparations was examined next. The drum-dried plasma proteins, both with and without starch additive showed no gelation ability. It is certainly associated with low solubility of those preparations. In the other cases (Fig. 2) this characteristic of plasma preparation was affected by drying temperature. The freeze-dried demonstrated better gel formation ability than spray-dried. This finding might be attributed to a milder thermal processing of protein in the former preparation.

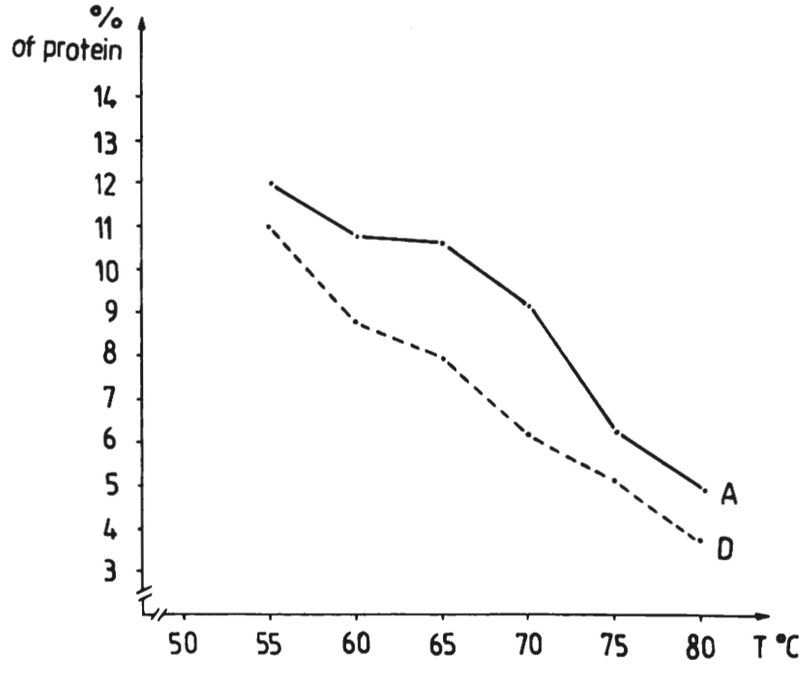

Fig. 2. Gel forming capacity of blood plasma preparations (percent of protein in geled solution); (description of A, D — see Table 2)

Nevertheless, it should be stressed that the figures illustrating gel formation ability of the examined preparations differ greatly from those of fresh blood plasma [3, 6].

Susceptibility to proteolitic enzymes action measured "in vitro" can be used as one of the characteristics determining the nutritional value of plasma preparation [9]. The experimental results of enzymatic digestibility determination (Table 4) are relatively high and witness the high value of these preparations as food.

Table 4. Digestibility of examined blood plasma preparations

Digestibility (%)	Code of preparation			
	A	B	C	D
Pepsin	33.0 (a)	30.0 (a)	32.0 (a)	32.3 (a)
Pepsin + tripsin	97.3 (a)	92.0 (b)	90.0 (c)	93.0 (a)

Note: identical letters within lines- lack of significant difference at P = 0.05
A, B, C, D — see Table 2

Major differences in the pepsin digestibility of these preparations were not found. It could be only seen that the spray-dried (A) preparation demonstrated the highest susceptibility to pepsin + tripsin action "in vitro". The relatively lower digestibility (pepsin + tripsin) of preparation C (with starch added) was expected since it is probable that the first stages (condensation) of non-enzymatic browing (Maillard reaction) would here occur [12].

SUMMARY AND CONCLUSIONS

The results of study presented above indicate that each of the drying techniques affected the basic physical and chemical characteristics of plasma preparations. These techniques — can be divided in a simplified way, into two categories, i.e.

— spray and frezee drying,
— drum drying.

The spray-nad frezee dried preparations demonstrated good solubility and emulsifying capacity being similar to those in plant protein concentrates and isolates. Therefore, they can be consider in the manufacture of cominuted meat products of high fat contents (e.g. Frankturters).

The drum dried plasma preparations demonstrate a low solubility but high swelling ability which make them similar to the concentrated (specially textured) proteins and suggest their use in the manufacture of less comminuted meat products (e.g. Luncheon Meat).

The use of starch additive during drying of blood plasma demonsrtrates two main advantages: the product can be easilly removed from the drying drum during processing and the preparation has very good swelling ability.

The results presented in this paper were a basis for commencing a study on the effect of plasma preparations on the quality of selected meat products. The results will be reported in another paper.

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WPŁYW METODY SUSZENIA NA WYBRANE WŁAŚCIWOŚCI PREPARATÓW BIAŁKOWYCH OTRZYMANYCH Z OSOCZA KRWI BYDLĘCEJ

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Streszczenie

Celem niniejszej pracy była ocena wybranych właściwości preparatów białkowych otrzymanych z osocza krwi bydlęcej przy użyciu trzech metod suszenia (suszenie rozpyłwowe, suszenie walcowe oraz liofilizacyjne).

Ocenie poddano następujące wyróżniki otrzymanych preparatów: zawartość białka, lipidów oraz tryptofanu, a także rozpuszczalność preparatów, ich pęczliwość, właściwości żelujące oraz strawność enzymatyczną "in vitro".

Stwierdzono, że badane preparaty charakteryzują się zróżnicowaną zawartością białka (od 54.7% w s.m. w preparacie suszonym walcowo, z dodatkiem soli ziemniaczanej, do 82,2% w s.m. w osoczu liofilizowanym) oraz lipidów (od 0,41% do 0,55% w s.m.). Osocze liofilizowane charakteryzowała najwyższa zawartość tryptofanu (0,78% białka) w porównaniu z pozostałymi preparatami (tab. 2).

Warunki suszenia wyraźnie wpływają na właściwości funkcjonalne badanych preparatów, a zwłaszcza ich rozpuszczalność w wodzie (od 2,75% dla osocza suszonego walcowo do 92, 75% dla osocza liofilizowanego) oraz właściwości emulgujące. Wyróżniki te są także zależne od obecności chlorku sodu w roztworze (tab. 3) Badane preparaty różnią się pęczliwością (rys. 1) oraz właściwościami żelującymi (rys. 2).

Osocze suszone rozpyłowo oraz liofilizowane cechuje wysoka podatność na działanie enzymów proteolitycznych (pepsyny i trypsyny) w warunkach "in vitro" (tab. 4).

Uzyskane wyniki badań mogą być brane pod uwagę przy podejmowaniu decyzji o sposobie wykorzystania suszonych preparatów z osocza krwi do celów spożywczych.