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TEXTURIZATION OF PROTEIN RECOVERED FROM BLOOD PLASMA

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Summary

Starting with blood plasma it was possible to obtain texturized products in the form of filaments or tape with a high nutritive value and high keeping power at room temperature. In order to achieve this it is advantageous the quick separation of plasma from blood, immediately after the blood collection, as well as its immediate mixture with 2% PRONALGINA HV and the extrusion through an apropriate spinneret deeped in an acetic acid solution pH 2.00 containing 5% calcium chloride bath. It is possible to reinforce the pigmentation of the final product with hemolized cruor at an adequate proportion.
The centesimal chemical composition from the final product can be regulated according to the degree of dehydration of the product and its digestability as well as its amino acids profile are rather interesting. Also the electron microscope photography reveals in the texturized products the trend towards the conversion of globular structures to fibrillar structures which along with pH 3.4 measured in the final product explains the high keeping power at room temperature. The texturized products raw or mixed with minced meat products undergo the traditional cooking operatios without alteration in their macroscopic structure.

AIMS

It is very tempting to get products with a high protein contents, edible for direct human consumption resembling meat slices or indirectly mixed with hamburgers, sausages, or other meat products, starting from blood plasma. These products would also be of a very high keeping quality at room temperature and low price.
In our country we have got yearly 410,700,250 and 220 thousand liters of blood (bovine and swine) in four zones. The first three zones are around 70 km apart and hence we can consider that it is possible to obtain a total of 946 thousand liters of plasma containing 75 tons of high value protein.
At a plant in one of the abattoirs on a zone mentioned earlier blood meal has been produced using from 8 to 9 kg of blood to yield around 1 kg blood meal, anktioned close to 35 escudos per kg. It has been known that in our country each gram of meat protein has been payed around 5 escudos while the same amount of milk protein (crude milk) it is worth around 2 $\frac{1}{2}$ escudos per gram, each gram of whole egg protein 1 1/2 escudos, there is no reason so far why one should pay for such a low price every gram of protein from blood, and similar situation applies to the protein from the gastric compartments from ruminants and lungs.
It is recognized that the biological value of proteins from such a diverse origin it is not the same, as well as the keeping quality of the raw materials from which they are a part and their comercial value.
The fact that it is possible to convert globular proteins (from blood or recovered or extracted from raw materials including eggs, fish, etc.) into fibrills (1) appears to be a good starting point in order to attempt to find a reasonable formule to valorize the protein fraction of good biological quality. It happens additionally that in the blood after the sedimentation from the blood plasma for texturization it is left over an important part from the red cells proteins that puts forward the problem of their possible extraction and the removal of the heme portion for a posterior valorization. The interconvertion of globular proteins into fibrills may be got either by an adequate former concentration of the protein solution (2) or by the incorporation of a convenient thickning agent (3) followed by extrusion under pressure through an apropriate opening (spinneret) and collecting the extruded product in physical or chemical conditions favouring the coagulation of the protein structure. On the other hand it is understood that each of these unitary operations it is likely to suffer different modifications that will influence powerfully the features of the final product obtained. Hence in the classical work about these matters an atempt has been made to get "strings" of texturized protein, and these "strings" should later be incorporated in a variety of food products (4). People have started with blood plasma or proteins extruded from gastro-intestinal reservoirs, lungs, or from diverse vegetal origins and including ectic proteins (5,6).
We were atracted also by the probability of producing laminated products in the form of tape that could look like meat analogs instead of "strings" of texturized protein. The coloring and scents that are possible to convey in the texturized products are a chalenging objective, too.
In the present care of our work we intended to get "strings" and "tapes" of texturized protein starting with bovine blood plasma to which they were added different types of thickning agents (polysacharides and its derivates) or other types of aditives that could be consumed directly (resembling small slices of meat or that could be incorporated in hamburgers or in the fabrication of sausages and so on.

EXPERIMENTAL METHODS

Collection and separation of plasma from bovine blood: the blood of bovine was got in a local abattoir in a sodium citrate solution (w/v). The blood was kept at room temperature while the sanitary inspection on the animals where it was coming from was taking place, as well as during their transportation to the laboratory which took about 30 minutes. After arrival at the laboratory the blood was chilled immediately or centrifuged under refrigeration in a MSE-Mistral 6L centrifuge with rotor swing-out buckets 4x1.000.1 at a 1000 x for 30 minutes. The blood plasma was recovered after decation and a part from the pellet was stored in order to be hemolized later with distilled water.
Spinning of protein fillaments and tapes - Bovine blood plasma was incorporated with various types of polysacharides or their derivatives. Thus we tryed: Sodium alginate from two trade marks (SIF-250 malhas, Pronalgine HV-alginato Y Coloides, Tuy, Ponte Vedra, Spain), Pectin from apple (V.Reis), and carrageninas (Ibergel C2 or Iberlacta K65). Any of these substances was added to the blood plasma at a percentage of 2% (w/v). After this incorporation we proceeded with a homogenization by mechanical means in the first trials with a type VIRTIS 45 homogenizer at high speed, and posterior we opted for an Ultra-Turrax at a high speed during

5 minutes.After the homogenization we carried out a chilled centrifugation at 1.000 g for 30 minutes.
The spinning dope got,contained in a Millipore 1 U.S. gal vessel or in another apparatus shown in Figure 1 was then extruded with air under a pressure of between 1,2 and 2kg per cm2 through a spinneret provided with 100 insulin type needles,each one with around 0.3mm diameter,or through another type of spinneret with an output slit 45mm x 0.3mm large,and the speed of extrusionwas 0.19m min.$^{-1}$ or higher. The spinneret was submerged in a plastic rectangular container with the acid bath(we used glacial acetic acid or edible lactic acid or edible citric acid) with different pH values that were going down until/could be as low as 2.00,and contained 5% calcium chloride(3,7,8). In order to give a certain color to the texturized products got we tried a variety of times hemolised pellets in various percentages in relation to the plasma before this one was incorporated with Pronalgina HV.
The container that contained initially the acid coagulation bath was around 50 cm long, the plasm being texturized along this path,and we limited ourselves to remove at the extremity oposed to the spinneret the product extruded with a certain tension which allowed the product obtained to be more or less straight inside the bath and finally it was removed to a washing bath with running tap water.
Trials with incorporation into the plasma of the following flavours:Lucta-SA.Barcelona - -Spain(Luctarona ahumado 9871A and Luctarona Carne 9821A);Fontarôme(Meat flavour 3403 and Smoke flavour 6556);IFF(Meat flavour liquid base 75.59.9600,Ham flavour liq 15.94.4403 and Smoke flavour liq 15.03.5110),before the plasma was mixed with the thickning agent.Any of the additives were used according to the producers directives for meat products.The texturized products we got were kept at room temperature(after they were washed in tap water)in touch with the air open glass or inside inside covered glass cup,or inside plastic bags of the kind used in meat industries but without any vacuum.

MAIN RSULTS

The conditions to which the plasma is subjected before separation are important for the degree of hemolysis caused and to the yield of plasma per litre of blood and also to a more or less successfull texturization procedure.We had the opportunity to see that one should chill the blood as quick as possible after its collection as well as to its centrifugation at 1000 x g(+3+4°C).The storage of the plasma in a freezer over a weekend or more considerable prejudicates the texture of the final product.The yield in plasma we have got is around 60% whole blood.
The defibrination of the blood at the very moment of its collection does not allow a reasonable quantity of plasma(yield bellow 60%) and there is a large degree of hemolysis.
The incorporation of apple pectin or carragenas(Ibergel C2 or Iberlecta k 65)does not allow strings or laminated products of a fair quality.Among the alginates used Pronalgina HV was the one for best results (Figure 2).
The incorporation into the homogenized plasma pronalgina of any of the flavours indicated before prejudicated the obtention of the texturized product that became less consistent and prejudicated the keeping power of the products.Therefore plasma-pronalgina homogenates containing 1% Lucko meat flavour texturized in an 18% acetic acid coagulation bath with 5% CaCl2 were unstable after 4 months at room temperature stored inside a plastic bag.They were green and produced gas and a stench.
Also the products texturized inside bath with 3% lactic acid and 5% CaCl2 were unstable after they had been stored for 4 months at room temperature.The same applies to the products well texturized inside an acetic acid pH 2.00 coagulation bath with 5% CaCl2.These baths contained ham liquid flavour.The incorporation of hemoglobin into the plasma(got by hemolysis of the pellet with distilled water)must be well balanced because an excess of hemoglobin causes an excessively dark color and time after storage becomes even darker. However it is possible to get stable color in texturized tapes if we work with 1% hemoglobin (Figure 3).
The acid bath employed to the texturization it is extremely important in this whole context. Between the three acid used,acetic,lactic and citric,always added in the same concentration (5%) of CaCl2 and working with identical final values of pH,the efficiency of texturization of the acetic acid it is very superior when compared to the other acids used as well as the keeping power of the products obtained,although without the drawback of acid giving a more intense scent and taste to the texturized products forcing more intense washings of the product obtained and even so without a complete success.
The final products of Pronalgina HV-plasma texturized with acetic acid pH 2.00 with 5% CaCl2 and after washing with running tape water gave a pH 3.4.
The speed of extrusion it is a heavy factor because very high speeds(very superior to 0.19m min.$^{-1}$ prevent the formation of a reasonable texturized whilst very low speeds give low yields of the final product.
In our average working conditions in order to get at the very moment of fabrication 1.8kg of texturized tapes it was necessary to extrude during 24 minutes.
The strings (Figure 4) or tapes(Figure 3) of plasma incorporated with Pronalgina HV,received in a bath of acetic pH 2.00,containing 5% Calcium Chloride and washed during about one hour in tape water had the following yield: 2.6 litres of plasma with Pronalgina HV incorporated yield 1.8kg of laminated products at the very moment of fabrication that lower to 1.4kg after 48 hours of fabrication.The texture of the laminated products and strings is very analogue to meat products,though its taste is slightly acidulated and with a background flavour that evoques alginate.After the texturized products were left for 15 days after fabrication at room temperature they shrinkle and they weigharound 50% less.
This explains its change in centesimal composition that brings a relative increase in the protein contents.

Centesimal chemical composition of the texturized products got

	On the day of production	5 days after production left at room temperature	15 days after production left at room temperature
Water	86%	82%	26,15%
Protein	10,3%	13%	48,13%
Calcium	170mg%	190mg%	ashes 6,91%
(By difference)			
Alginate	3,53%	4,8%	16,81%

The laminated products after they leave the

Table

	% per 100 g of protein													
	Lys	His	Arg.	Asp.	Thr	Ser	Glu	Pro	Phe	Ala	Cis	Val	Met	Ile	Leu
Texturized plasm	0.13	3.16	5.52	9.82	6.28	6.83	14.65	5.70	5.11	4.38	2.76	6.55	1.21	3.28	9.30
Chicken egg	7.20	2.30	7.20		4.70				6.00			7.50	3.00	6.00	7.20
Cow milk	7.90	3.00	3.90		4.70				5.40			7.10	2.50	6.50	10.10
Beef	7.80	2.80	7.10		4.50				4.10			5.60	3.80	6.20	7.50

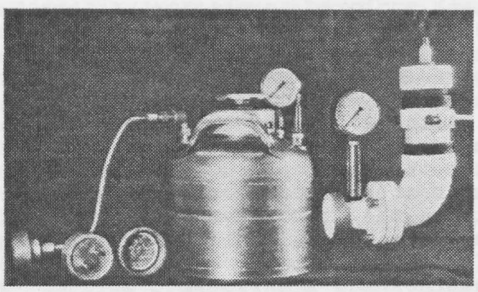

Fig.1
Apparatus for spinning dope. Spinneret with insulin needles (right) or with an output slit 45mm x ⌀3 mm (left)

Fig.2 - Tapes of plasma - Pronalgina HV spinned into acetic acid coagulation at pH 2.00 with 5% CaCl2, stored one year at room temperature in plastic bag.

Fig. 3 - Idem Fig.2 with hemoglobin hemolizate incorporated, stored without any cover.

Fig.5
Electron micrograph of the texturized product. This material was embedded in Epon-araldite and stained with uranyl acetate and lead citrate (x16000).

spinneret into the coagulation bath reduce the width around one half, become thicker, but all depends on the tension applied in order to distend the tape as it is recovered and goes through the coagulation bath.

We have kept strings and laminated products from texturized blood plasma containing Pronalgina HV and got in acetic acid containing calcium chloride for around three years without any alteration except for the normal dehydration for those that are exposed to the air, however there lent after they are soaked in water become rehydrated and show the normal consistency typical of the very moment of fabrication.

The microbial analysis reveals that in the moment of production these texturized products are paucimicrobial ($< 10^2$/gram) and the keeping power without any protection or simply conditioned inside small plastic bags are the ones quoted above.

The digestibility coeficients of the same texturized products from blood plasma containing Pronalgina HV and got in acetic acid pH 2.00 and containing 5% calcium chloride were the following:

Digestibility coeficients in vitro

Pepsin	24 hours...92,6%	HCl	24 hours...51,5%
"	48 hours...93,4%	"	24 hours...57,9%
"	48 hours...94%	"	48 hours...47,0%
		"	48 hours...56,90%

The amino acids composition of an acid hydrolisis carried upon the texturized products it is indicated next comparing it with the values corresponding to whole protein from chicken's egg, cow's milk and beef. (VIDE TABLE)

microscope
Electron photographs of the texturized products in the conditions referred (FIG.5) show a certain conversion of the globular on fibrillar structures, certainly the biological basis of the high keeping pover from the final products obtained as well as their relatively firm texture. The texturized products obtained support cooking operations such as frying and boiling during half an hour and they remain whole and without alteration in their macroscopic structure and the same applies when they are minced for the fabrication of hamburger on sausages.

In the case of hamburgers incorporated with texturized plasma with Pronalgina HV in acetic acid containing calcium chloride the flavour was normal. In the texturized tapes subjected to the cooking operation without any other addition the flavour revealed a slight acidulated taste whilst the aromatic background of the alginates practically desappeared whilst the resistence of the product to chewing was very analogue to the one from meat products.

The keeping power of the well texturized products with any of the spinnerets with Pronalgina HV, acetic acid pH 2.00 containing 5% calcium chloride it is the same whatever conditioning form is used.

Therefore if they are packed in small closed plastic bags on the very day of fabrication some exsudation of liquid is noted and it collects inside the bag and wets the texturized products giving them a wet look and and without any inconvenient upon their keeping power. On the other hand if the products are exposed to the air without any protection upon a glass plate they become dry without becoming rotten but they keep nevertheless their capacity to rehydrate and acquired their normal consistency when soaked in water.

CONCLUSIONS

Starting with blood plasma it is possible to obtain texturized products with a high nutritio nal value and strong keeping powder at room temperature. Subsequent studies investigating the viability of an industrialization of the process are fully justified.

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