THE UTILIZATION OF BLOOD AND OTHER SLAUGHTER BY-PRODUCTS.

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The most vital problem of nutrition is to meet requirements of man in protein. It is the level of protein supply that determines human health condition, physical development and working capacity, and in case of children - their mental ability.

With the present knowledge it is not enough to speak only about the total protein in foods, it is necessary to consider protein quality.

At present, it is found that, to provide normal vital activity of the body, food must contain certain sets of essential amino acids. Most suitable for nutrition are the majority of animal proteins, their amino acid compostition being similar to that of human tissues.

In the nutrition of a considerable part of the world population a deficit of three amino acids is observed, viz. tryptophane, lysine and methionine, which limit food assimilation. This is due, primarily, to the fact that in the diet of the population of developing countries there predominate foods of plant origin, especially cereals, low in tryptophane, lysine and methionine. Animal products are much richer in the above amino acids. Therefore, animal proteins are not only readily assimilable, but improve greatly the digestion of plant proteins and allow to balance the amino acid composition of fodds. Animal proteins are 1.5 times as more efficient as compared to plant proteins.

The present annual world deficit of the total protein constitutes about 5 mln t, if a daily demand per capita is approximately 90 g (including 50.6 g animal protein, according to the FAO data).

Some scientists think that increases in the world protein resources can be achieved by means of intensifying agricultural production and producing the highest possible amount of ordinary food products, first of all meat and dairy ones, of developing fishing and pisciculture, of preventing protein losses, of developing food products of a high biological value, of utilizing oil-seed protein (soy-bean, sunflower, etc.) for human nutrition, of promoting research projects aimed at producing single-cell proteins, of fulfilling research projects concerned with possible manufacture of synthetic foods.

Livestock processing results in considerable amount of raw by-products still used insufficiently for edible purposes.

When considering various slaughter products, great attention is paid to the amount of muscle, fat and some offals (liver, tongue), but such by-products as blood, bones, spleen, lungs, tripe, abomasum, etc. are mostly underestimated though they contain much perfect protein.

Of all the slaughter products blood, offals, bones and other by-products constitute about 1/3. All of them can serve an additional source of human nutrition and can, to a great degree, supplement the world protein insufficiency.

By protein content (13-18%) and amino acid composition blood, liver, tongue, spleen, heart, kidneys do not practically differ from lean meat (Table 1).

A considerable amount of animal protein is also contained in such less valuable (by the amino acid composition) products as lungs, tripe, abomasum, ears, lips, weasand, rind, intestines, bones, etc.

As very important task of the meat industry is the maximum conversion of protein-containing raw materials, resulting from slaughter animals processing, into food products. This forces us to re-consider the basic trends in raw materials utilization.

Two trends can be traced in solving the problem of the rational use of meat reserves: on the one hand, the rational utilization of a meat carcass, on the other hand - the maximum use of cattle processing products for food.

The purpose of the rational utilization of a meat carcass is to give the best cuts of natural meat to retail shops, and less valuable cuts - to processing into sausages, pastes, chops, etc.

Of great importance for solving the problem of the rational utilization of raw materials and of increasing protein resources is the maximum possible collection of edible blood, T a b l e 1

Comparative amino acid composition of meat, blood and 1st and 2nd grade by-products (% of protein)

	Protein	Indispensible amino acids								
		Tryptophane	Lysine	Leucine	Isoleucine	Methionine	Valine	Treonine	Phenylalanine	Total
Meat	18.0	1.1	8.4	7.6	4.7	2.5	5.7	4.6	4.5	39.1
Blood	18.0	1.4	9.2	11.6	2.3	1.2	8.3	4.4	7.7	46.1
1st grade by-products										
Liver	17.4	0.88	7.39	7.71	4.7	3.2	10.76	3.23	5.21	43.08
Kidneys	12.5	1.7	5.5	8.0	5.6	2.7	5.3	4.6	5.5	38.9
Tongue	13.6	0.84	7.38	7.20	2.85	-	4.24	3.01	-	25.52
Brain	9.0	1.40	4.90	5.80	2.61	3.0	4.45	-	4.25	26.41
Heart	15.2	1.97	8.70	9.83	1.63	-	5.86	4.60	2.23	32.59
Udder	12.3	0.63	4.99	3.30	1.17	-	-	1.84	1.36	12.39
Diaphragm	23.0	0.45	4.67	5.22	1.18	-	1.08	1.93	1.96	16.49
2nd grade by-products										
Tripe	14.8	0.89	7.30	4.73	2.59	1.00	2.21	-	2.46	21.18
Lungs	15.2	0.88	4.31	5.23	2.16	1.00	2.15	2.84	4.20	22.77
Spleen	16.0	0.88	5.55	8.31	2.18	1.90	4.10	3.59	3.26	29.72
Lips	-	0.54	4.09	3.08	1.83	-	3.30	2.04	3.11	17.99

when processing all kinds of livestock, to convert it into food products.

The amount of edible blood collected by means of a hollow knife is about 3.5% of the liveweight or about 50% of the total blood yield. Each ton of blood yields nearly 630 kg to plasma and 360 kg of red cells with the protein content of appr. 7 and 38%, respectively.

Through improving blood collection and preservation methods and sanitary and hygienic conditions of these processes, it is possible to markedly raise blood yields for edible purposes.

Traditionally, blood has been used in blood sausages, head-cheeses, puddings and in other products in DBR, GDR, Poland, ČSSR, Great Britain, etc. However, in some countries the manufacture of products with blood added is restricted with low consumer's demand; the use of whole blood in cooked sausages is also limited due to impairing finished product colour.

Blood plasma is used much wider - both liquid and powdered - in meat products (10-20% and 1.0-1.5% of meat weight, respectively). By protein content each 3 tons of liquid plasma may replace 1 ton of beef.

Red blood cells are not, practically, used for edible purposes and are, mainly, processed into blood meal, the main cause being a dark colour which makes the appearance of a meat product undesirable.

The basic protein of red blood cells is haemoglobin containing all essential amino acids, iso-leucine being very insignificant 0.2%. At the same time globin can supply histidine (7.8%) required by a growing organism.

Combining globin with proteins rich in iso-leucine, it is possible to get a product having an optimum amino acid analyses. Such proteins include meat and milk ones.

Blood clarification provokes interest of many researchers. The principle of this process is based on haemoglobin preunbalancing and heme colouring matter/globin protein separation or on heme treatment with strong oxidants (perhydrol, etc.).

Promising is Anson and Mirsky's method for clarifying blood, which uses aqueous acidified solutions to hemolyze haemoglobin followed with acetone extraction of heme. On the basis of this method, in a number of countries (Sweden, the USA, the USSR, etc.) experimental plants to produce globin have been developed and globin functional properties are being widely studied aimed at giving recommendations on its application in meat products (P.T. Tybor, C.W. Dill, K.M. Dull, A.M. Hermansson, E. Tornberg, V. Palmin, etc.). Globin commercial production will permit to increase significantly the supplies of valuable animal protein.

In the USSR blood clarification was investigated in several research programmes in two ways: by haemoglobin splitting with strong oxidants and solvents which partially destroy the protein moiety; or by physical treatments without chemical agents. A method has been developed based upon blood fine emulsification in a protein-fat medium. This process is performed in a sonic hydrodynamic unit. The essence of the method lies in that during sonication emulsion components are being dispersed and re-arranged, this resulting in a stable lipoprotein complex surrounded by a solvate membrane masking blood colour.

The colour of the emulsion obtained depends upon system dispersity and component proportions.

Changes in emulsion colour as related to system dispersity are shown in Fig. 1 and Table 2. It is clear that the highest dispersity characterized with the maximum peak on the distribution curve is accompanied with the greatest degree of blood clarification.

Table 2

Emulsion colour intensity as related to system dispersity

Characteristics	Sonication time, min.							
	3	±m	5	±m	7	±m	9	±m
Average diametre of a fat globule, nm	3.14	0.022	2.65	0.057	1.93	0.004	2.48	0.047
Number of vizualized fat globules, pcs	303	7.6	660	8.6	1272	18.6	7.3	17.6
Total surface area of stabilizer layers, m^2	9518	94.9	14449	141.3	15209	157.9	14200	195.0
Fat globules amount	75.3	0.29	85.6	0.24	96.2	0.352	88.1	0.595
Optical density	0.8411	0.001	0.8224	0.001	0.8031	0.0003	0.8305	0.004

These relations are determined for various ratios of emulsion components.

A component ratio has been chosen at which emulsion colour is close to that of cooked sausages and its chemical composition is equal to that of semi-fatty pork.

Such emulsion can be added to cooked sausages to replace meat (1:1) without a deliterous effect upon the organoleptical and food qualities of the finisched product.

In the USSR a method has been developed for producing a protein enricher by means of co-precipitating proteins of slaughter animal blood mixed with skimmed milk (A.A. Pokrovsky, P.P. Levyant). Proteins are precipitated with $CaCl_2$ and heating the mixture up to 95°C. Milk and blood proteins combination enriches the amino acid and mineral composition of a complex product. This protein enricher is recommended as an additive to improve the nutritive value of many products, e.g. hamburgers, sausages, pastes, confectionery products etc. A peculiar feature is its possible wide application for dietotherapy.

Most important for human nutrition are offals.

According to the nomenclature of a number of countries, including the USSR, all by-products are divided into two categories as related to their food value.

1st category by-products include tongue, liver, brains, heart, kidneys, udder.

2nd category by-products include spleen, lungs, tripe, abomasum, pig stomach, weasand, lips, ears, trachea, beef and pig feet. The yield of the 1st category by-products averages 3.0%, that of the 2nd category by-products - 7.0% of the liveweight, the total yield constituting about 10%.

Despite a high food value, most by-products are not used for edible purposes because no recommendations exist on their processing and utilization.

Some offals of the 1st category (tongue, liver, heart, etc.) are, mainly, used for retail sale and, to a small extent, in sausages (liver and blood ones, head-cheeses, gellied feet), which have short shelf-life and are not in great consumer´s demand, as well as in canned meats.

By-products are utilized in meats on a limited scale, as their processing requires much labour and high hygienic and sanitary conditions of production. In addition, they impart specific flavour and appearance to traditional meats, if used in their natural form.

Mostly, by-products are processed into feeding meal.

To use them wider as a protein edible additive, it is necessary to develop methods for their pre-treatment.

Secondary raw materials can be converted into edible protein hydrolyzates widely used in food industries in the USA, Great Britain, France, Japan, Holland, etc.; hydrolyzate production is increasing in Socialist countries: GDR, ČSSR, SRR, PPR, The USSR.

Protein hydrolyzates are used as effective flavour additives to various foods: dry soups, beef steaks, sausages, canned foods, etc.

In many countries hydrolyzates are used in combination with plant proteins or other non-meat ingredients (starch, powdered milk, etc.).

Hydrolyzates contain various amino acids, including essential ones. These amino acids stimulate the secretion of digestive juices. The absence of purine bases in them improves hydrolyzates physiological effect and broadens a possible rang of their application.

A promising trend in by-product utilization for human nutrition is their processing into protein preparations of high biological value, water-binding and emulsifying capacity. Here, successful research is being carried out in the USA (Research Vio-Bin Corporation, Monticello, Illinois). Levin described azeotropic extraction to remove water and lipids from by-products at beef and pork plants. Drying at a relatively low temperature yields high-protein powder (meat protein concentrate) which may be used as a food enriching agent for human nutrition. As raw materials for MPC served pig brains, duodenum, heart, liver, lungs, kidneys, spleen and stomach, as well as beef whole blood.

To estimate the prospects of the application of high-protein powders in comminuted meats, their emulsifying properties and emulsion stability were studied (Satterlee et al.). It was found that dry defatted preparations made of some by-products have a high protein content, good emulsifying properties and can be used in comminuted meats.

Possible production of a protein concentrate, a mixture of powdered by-products and bone meat, was also studied. Food mixtures prepared by Vio-Bin from several by-products and combined with pig bone meal can be used as protein additives in foods for human nutrition.

Another way of utilizing by-products for nutrition is the development of novel meat products similar to conventional ones but more stable in storage than liver and blood sausages, gellied feet and head-cheeses. Such products represent cooked or semi-smoked sausages, into which pre-treated mixed by-products of any category are incorporated as pastes, suspensions or emulsions. Pre-treatment involves trimming, flushing and fine comminution with water and other components, if necessary, added.

Interesting formulations of novel paste-like foods containing by-products, TVP, salt and spices have been patented. Such pastes may be moulded or used as garnish for sandwiches (the USA, France).

A technology for processing raw materials rich in connective tissue (meat trimmings, diaphragm) in a Comitrol-type unite (Townsend Engineering, Holland) deserves approval, as it renders it possible to obtain pressed semi-finished products, which are close to natural meat by their structure, and thus to rationally use meat resouroes.

As sources of animal protein may also serve bones, intestines and other keratin-containing materials.

There have been developed and patented procedures for producing edible protein from enzymatically treated animal bones. The resulting protein concentrates are suitable for enriching products low in lysine.

Various methods for additional processing of bones after primary meat separation, aimed at the maximum utilization of all meaty materials for meats production, are gaining wide popularity (Canada Packers; Paoli; Lyngaard, etc.).

In some countries, keratin proteins are investigated with the purpose of their incorporation into foods; entensive studies are concerned with the isolation of such amino acids as glutamic one, threonine and lysine from keratin-containing materials.

Thus, novel and significant sources of protein food for human nutrition can result from processing livestock slaughter and dressing wastes.

ВЛИЯНИЕ ПРОДОЛЖИТЕЛЬНОСТИ ОЗВУЧИВАНИЯ НА ДИСПЕРСНОСТЬ ЭМУЛЬСИИ