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Protein sources for pig feeding in Yugoslavia

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The intensive production of pigs (as far as feeding is concerned) depends on a balanced supply of all categories of pigs with the necessary amounts of energy, proteins, minerals and vitamins.

As nutritive substances with a special function and effect, proteins play an essential part in this complex because they participate in almost all processes of metabolism in pigs and because they are the most valuable component of the final product, i.e. meat. In feeds for livestock, and thus also for pigs, they cannot be replaced with other nutritive substances.

Their presence in certain amounts and in a particular quality is indispensable in feeds for all phases of the lifecycle of pigs:

- *reproduction – in animals in the processes of ovulation, service and fertilization; for the growth and development of the embryo and the foetus; in the production and composition of milk; and in the processes of spermatogenesis in boars;*
- *growth and fattening – in the processes of post-natal development of the young and in the individual stages of further growth where an intensive development of muscle tissue provides the practical basis for meat production.*

The protein requirements of pigs are covered on the basis of adopted standards for individual categories of pigs. Departure from these standards, by reducing the proportion of proteins in rations, generally results in adverse consequences for the

processes mentioned above, including meat production and, ultimately, the health of pigs.

I - Sources of protein in Yugoslavia

The production of livestock feeds in Yugoslavia is highly variable because the edaphic and ecological conditions relevant to the production of particular crops differ considerably from region to region. As a rule, in the country's northern parts, a rich soil and favourable climatic conditions make it possible to grow a variety of crops with high yields of carbohydrate and protein-rich feeds. In its southern parts, however, due to a poorer soil and the influence of a Mediterranean climate, there are only meagre sources of livestock feeds. Generally speaking, Yugoslavia is a major producer of livestock feeds, primarily those containing carbohydrates.

The domestic production of carbohydrate feeds fully covers the requirements of the country's total number of livestock, both ruminants and non-ruminants, while the production of protein feeds covers the requirements of ruminants but only partly those of non-ruminants. The difference is due to green voluminous feeds which non-ruminants (pigs and poultry) can only use in very limited amounts.

Proteins for pig feeding are obtained from various sources. Although all protein feeds come from two main sources – vegetable and animal – modern

techniques in the processing and preparation of human food and animal feeds have introduced many novelties which require a more careful and detailed classification and knowledge of the chemical and biological characteristics of all feeds, especially those containing proteins. Because of the continuing world-wide shortage of protein foods, both for human consumption and livestock feeds, efforts are being made to find new sources of protein food, because in the future both human and animal requirements for protein will increasingly exceed the produced and marketable quantities of protein food.

1. Protein feeds of vegetable origin for pigs

Yugoslavia's plant production offers immense possibilities for the production of quality protein. Notable progress in this field has been achieved over the past ten years or so when, with the help of breeders, many new sorts and hybrids with a higher content and better quality of protein were developed both among cereals (maize, barley, oats and rye) and oil plants such as soybean, sunflowers and rape. Peas, horse-beans, lupine and other kinds of fodder plants are also currently being produced in increasing amounts. Grown either as main crops or as second harvests by means of irrigation, these crops offer ample and real possibilities for raising the production of proteins for the feeding of livestock, including pigs.

1.1. Non-specific sources of vegetable proteins.

Yugoslavia is a maize growing country producing 11-12 million tons of dry maize grain per year. More than 80% of this maize is used for feeding livestock, while almost five million tons are used for feeding pigs. Rations for all categories of pigs in Yugoslavia contain mostly maize as the basic energy component, which for the feeding of piglets is supplemented with minor quantities of barley. Thus the proportion of maize is about 30 - 50% for young pigs and 50 - 70% for breeding and fattening pigs. More than 70% of the country's pig producers grow their own maize and other cereals. They feed their pigs with rations which contain 70 - 80% of maize and are supplemented with the necessary protein feeds to which minerals and vitamins are added.

The average content of raw proteins in maize grain in Yugoslavia is 8.0 - 8.5%, in barley 9.5 - 10%, and in oats about 11%. Thus it may be said

that in this country about 60% of the proteins required for pig feeding is obtained from cereals, mostly maize.

The production of other cereals and their utilization in pig feeding are of much smaller proportions. According to existing Yugoslav regulations, wheat may not be used for feeding livestock, while the combined total production of barley, oats and rye does not exceed 10% of the total maize production. For Yugoslav edaphic and ecological conditions, maize is the most reliable and most profitable grain crop.

Since maize protein has no high biological value and is particularly deficient in lysine, pig rations have to be supplemented with the necessary quantities of quality proteins.

Large socially owned farms and private farmers, who produce pigs in co-operation with the social sector, feed their pigs mostly with balanced feed mixtures with regard to energy, proteins, minerals and vitamins.

However, the rest of the farmers (40 - 50%) predominantly use protein feeds produced on their own farms, i.e. green alfalfa and clover and, in recent times, increasing amounts of leguminous grain-peas, horse-beans and lupine. Since protein-rich feeds are two to three times more expensive than energy feeds, many producers try to economize by giving their pigs feeds with a lower protein content, although they pay for this heavily through reduced meat production, poorer conversion and great differences in the weight of individual animals.

As mentioned above, it is estimated that about 60% of the total requirements of protein for pig feeding in Yugoslavia is provided through maize, barley, oats, rye and wheat bran, i.e. about 400,000 tons of raw proteins from maize, about 40,000 tons from barley, oats and rye, and about 40,000 tons from wheat bran.

1.2. Oil meals

Yugoslavia grows a considerable variety of crops for the production of oil such as soybeans, sunflowers, rape, pumpkins, peanuts, flax and sesame. For the production of oil meals, which are used exclusively for feeding livestock, only three really come into consideration: soybeans, sunflowers and rape. The production of oil meals from other oil plants is of a regional and sporadic

character and thus their amounts have very little effect on the provision of livestock with proteins.

Soybean meal is a highly appreciated protein feed for pigs in Yugoslavia. According to the country's regulations regarding the quality of livestock feeds, soybean meal must contain a minimum of 44% of raw proteins and a maximum of 7% of crude fibre. Proteins of soybean have a high biological value.

In Yugoslavia, soybean meal is used in pig rations as a protein supplement to maize, mostly in a proportion of 10 - 20%. It is higher in rations for young pigs and less in rations for breeding and fattening pigs which, apart from soybean meal, contain sunflower meal and rapeseed meal.

In recent years increasing attention has been paid in Yugoslavia to the domestic production of soybeans. Compared with 1975, when slightly more than 20,000 tons of soybean meal were produced, in 1985 this reached 183,000 tons. However, the requirements for soybean meal are still much greater, and in 1985 Yugoslavia had to import 257,000 tons of soybean meal (calculated from the total imports of soybean grain and soybean meal) for livestock production. Of these total quantities of soybean meal, more than 50% were used for feeding pigs.

Sunflower oil meal is a valuable source of proteins for pig feeding, although as regards chemical composition and suitability for pig feeding it differs considerably from soybean meal. Due to the technology of sunflower oil meal production, considerable amounts of husks remain in the meal and this affects the level of raw proteins in it. According to Yugoslav regulations, sunflower oil meal must contain a minimum of 33.5% of raw proteins, while the proportion of crude fibre in quality sunflower oil meal must not exceed 18%. The proteins of sunflower oil meal are deficient in lysine but richer in methionine, but this deficiency can be compensated for by balancing rations with other protein feeds. The limitation regarding the use of major amounts of soybean meal in rations for young pigs, in addition to the lysine deficiency in this meal, relates to the high proportion of cellulose it contains. Major efforts have been made in Yugoslavia in recent years to improve the technology of the production of quality sunflowers, and currently - though still in minor quantities - sunflower oil meal is produced with 44% of proteins, and sunflower flour with 50% of proteins.

Until some five or six years ago, Yugoslavia was a major producer of sunflowers, with a production of more than 200,000 tons of sunflower oil meal per year. However, a plant disease (not only in Yugoslavia) has halved this production, reducing it to the present total annual output of about 100,000 tons per year. Selection of new sunflower varieties resistant to diseases is expected to increase the production of this meal.

Rapeseed oil meal is a protein feed which in recent years has been increasingly utilized as a minor protein supplement to rations for pig feeding. It is mostly added to rations for fattening pigs and breeding pigs. The limitation as regards the amount of rapeseed oil meal in rations for pig feeding is due to the adverse effect of the major amounts of glucosinolate and erucic acid contained in the earlier varieties. The new varieties of rape which have a low content of these components can be successfully used in pig feeding, although practical experience has shown that the proportion of this meal in pig rations should not exceed 10%. This meal is slightly poorer in proteins (28 - 32%), but has a very favourable amino-acid composition.

Yugoslavia produces about 50,000 tons of rapeseed oil meal per year, 20,000 tons of which are used for pig feeding.

1.3. Leguminous seeds

There has been a growing interest in the production of leguminous plants for seed production in Yugoslavia in recent years. Besides the production of soybeans, which are rarely used in the form of seeds being almost exclusively processed into oil meal, increasingly large areas are now sown with peas, horse-beans and lupine.

Peas are a suitable protein feed for pigs because they contain 24 - 26% of raw proteins (certain varieties as much as 30%) of a comparatively favourable amino-acid composition, and because they contain similar or even greater quantities of lysine than soybeans, although they possess less methionine and cystine than soybean meal. As in the seeds of all leguminous plants, the Ca:P ratio is unfavourable, amounting to 1:4. Peas are marked by great digestibility of all nutritive substances. In rations for breeding and fattening pigs, peas account for 5 - 15%. Until recently the production of peas in Yugoslavia was very limited, but has since notably increased and, with yields

varying from 2 - 4 t/ha, now totals about 6,000 tons annually.

In some parts of Yugoslavia horse-beans are a traditional protein crop used both for human consumption and in livestock feeding. Horse-beans contain on average 25 - 28% of crude proteins marked by a high digestibility, but a low content of methionine and cystine. The lysine level in horse-beans is rather high, but lower than that in soybeans. The biological value of horse-beans proteins is rather high: slightly lower than that in soybeans but higher than that of groundnuts. Like the seeds of other leguminous plants, horse-beans are rich in potassium and phosphorus, but have a low calcium content, and the Ca:P ratio is thus mostly 1:4 or 1:5. Investigations undertaken over the past few years in Yugoslavia on the use of seeds of leguminous plants in pig diets have shown that horse-beans can be used effectively in rations for fattening and breeding pigs in a proportion of 5 - 15%.

The areas currently used for growing horse-beans in Yugoslavia are still small, but plans for the period up to 1990 envisage a total 6,000 - 8,000 ha for horse-bean production. With yields of 2.5 - 3 tons/ha, this would ensure an annual output of 17,000 - 20,000 tons of this valuable protein feed for pig feeding.

For a long time lupine was a highly appreciated crop in Yugoslavia, but primarily as green manure and only partly for the feeding of ruminants. New sorts of sweet lupine have opened the way for the production both of fodder for ruminants and of seeds for feeding ruminants and non-ruminants. Lupine seeds are marked by a high content of raw proteins (38 - 42%) with a comparatively favourable amino-acid composition, but low methionine and tryptophane contents. With yields varying from 3 - 4 t/ha or even more (thus exceeding those of soybeans), lupine is a crop from which large amounts of protein per hectare can be obtained.

Results of the investigations carried out on pigs in Yugoslavia in recent years have shown that, in comparison with peas and horse-beans, 5 - 15% of lupine in rations results in slightly lower gains and feed efficiency. However, these investigations should be continued in order to reach definite conclusions.

According to many experts, lupine is the protein plant of the future and therefore Yugoslavia will

also pay appropriate attention to this crop, since the country has real possibilities for a comparatively large production of this feed.

1.4. Other vegetable sources of protein

Yugoslavia produces about 1.8 million tons of alfalfa hay and about 1.2 million tons of clover hay per year.

It is believed that a certain proportion of green alfalfa (which is difficult to estimate) is used for feeding pigs on private farms, where it provides a rather important source of protein, primarily for feeding breeding sows and, to a lesser extent, for feeding fattening pigs.

The production of alfalfa meal began to be intensely developed in Yugoslavia some 20 years ago. Due to the world energy crisis it has since dropped considerably to reach the current total output of about 80,000 tons, which falls short of the country's requirements for the feeding of pigs and poultry.

On large pig and co-operative farms, dehydrated alfalfa accounts for 2 - 5% in the pig rations, and with a content of 17 - 20% of proteins of high biological value it is a valuable source of proteins for feeding pigs.

Increasing attention is being devoted in Yugoslavia to the production of proteins through pressing green plants to obtain vegetable juice. The main source of vegetable juice is alfalfa, followed by various types of clover and grass. This currently small production is expected to increase considerably in the coming years.

Like many other countries, Yugoslavia is also a potential producer of single-cell (microbial) protein from waste water of the food industry, molasses, marc, straw and maize stalks, the cellulose industry, and urban refuse. Although this is only beginning, technological solutions already exist for all aspects of this production and for the many possibilities for producing proteins for feeding pigs and poultry.

2. Protein feeds of animal origin for pigs

Feeds of this group contain large amounts of proteins of high biological value and thus are a highly valuable source of good proteins for pig feeding. Their practical utilization in the feeding of any animals, and thus also of pigs, is limited by

their high price on the international and domestic market.

Yugoslavia does not produce sufficient quantities of these feeds, although the country has real possibilities for an increased production of most of them.

2.1. Fish meal

Good quality fish meal is a highly valuable protein feed for pigs, especially for feeding pigs of up to 20 - 30 kg. Today it is no longer necessary to add fish meal to the rations for other categories of pigs.

According to the Yugoslav regulations on the quality of livestock feeds, quality fish meal must contain a minimum of 73% of proteins, and second class fish meal a minimum of 54% of proteins. The main quality of fish meal is its excellent composition of amino-acids which also means a high biological value of its proteins, and a high digestibility of these proteins in pig feeding (90%).

Yugoslavia covers most of its requirements of fish meal by imports, and this will continue to be the case in the future because the country's possibilities for major production of fish meal are rather limited. However, efforts are being made to keep imports of fish meal (at present 80,000 - 120,000 tons annually) as low as possible, since in pig and poultry feeding fish meal can to a considerable extent be substituted with other, less expensive protein feeds.

2.2. Meat meal and meat-and-bone meal

Yugoslavia has a comparatively large number of livestock of various kinds and thus has available large quantities of by-products and offal of the slaughtering industry, although all possibilities for their utilization are not yet exploited. The country's annual output of about 50,000 tons of meat meal and meat-and-bone meal could at least be doubled if all the possibilities for its production were made use of, or if the utilization of offal and waste from the slaughtering industry was increased. Plans are underway for the construction of new processing facilities for increased production.

Meat meal and meat-and-bone meal are valuable protein feeds for pig feeding since they contain about 50% of proteins of high biological value, although this value is slightly lower than that of

fish meal. Yugoslav pig breeders use considerable amounts of meat meal and meat-and-bone meal, especially for feeding young pigs, and this is one of the reasons why Yugoslavia imports almost the same amounts of meat meal as it produces.

2.3. Blood meal

Blood meal has a high content of proteins (more than 80%) which, regarding biological value, is not as good as fish meal or meat meal, while having a lower digestibility and poor taste. However, new blood processing techniques make it possible to obtain blood meal as a highly valuable protein feed for pigs and poultry.

In Yugoslavia blood meal for pig feeding is used only in small proportions because of the very limited domestic output of this feed.

2.4. Milk and whey

Skimmed milk and whey are very valuable feeds for pigs: skimmed milk as a source of protein, and whey as a source of lactose. Liquid skimmed milk is used for feeding young pigs and fattening pigs on co-operative and private farms where the farmers also use all the whey produced on their farms for pig feeding. Because of the very high price of domestically produced dried skimmed milk, publicly owned farms use this feed in comparatively small quantities and exclusively for feeding young pigs. Yugoslavia also produces dried whey, which is used partly for pig feeding, but its price is also rather high. The utilization of byproducts of Yugoslavia's milk industry is considered inadequate since considerable quantities of these products are available on the domestic market.

II - Yugoslavia's requirements for protein feeds for pigs

In order to give a picture of Yugoslavia's annual requirements for protein feeds for pig feeding, we present here the main indices regarding the number of pigs, or individual categories of pigs, in 1984 and, on this basis, the requirements for protein livestock feeds for that year.

Official statistics regarding the number of pigs in Yugoslavia (Tables 1, 2 and 3).

In 1984, Yugoslavia produced a total of 569,000 tons of pig meat (excluding bacon and lard, i.e., 47% of the live weight of pigs).

The amounts of livestock feeds used for this production, according to official data and the author's own estimates can be found in Table 4.

This review of the required amounts of feeds, which has been composed on the basis of the amounts of feeds used in the previous year, shows that in 1984 for the country's entire pig meat production, about 700,000 tons of proteins were used and that a greater meat output, according to the author's own estimate, would require about 800,000 - 850,000 tons of proteins.

III - Current situation and prospects

Of the indicated quantities of feeds,

Yugoslavia fully covers the requirements of pigs for maize, barley and oats, wheat bran, dried skimmed milk, alfalfa meal and sunflower and rape-seed oil meal.

At present, about 30% of the total requirements for soybean meal for all types of livestock is covered with domestic production, while 70% is imported. Yugoslavia also covers through imports its total requirements for fish meal and about 50% of its meat meal requirements.

Great efforts are now being made in Yugoslavia to considerably increase the production of the most important vegetable crops for the production of protein feeds, i.e. soybeans, sunflowers and rape, so that by the year 2000 the production of sunflowers and rape would meet the growing requirements of all kinds of livestock, while domestic production of soybeans would cover about 75% of the requirements for all kinds of animals.

Table 1: Number of pigs in Yugoslavia, 1984

Number of pigs at the beginning of the year	Bred	Slaughtered	Losses (dead pigs or eliminated from breeding and fattening)	Number of pigs at the end of the year
9,336,000	16,309,000	14,418,000	2,550,000	8,673,000

Source: Yugoslav Statistical Year Book, 1984

Table 2: Number of pigs at the beginning of 1985

Breeding sows and gilts	Pigs up to 6 months of age	Pigs over 6 months of age	Fattening pigs
1,350,000	5,184,000	1,121,000	972,000

Source: as above

Table 3: Number of pigs slaughtered in 1984

Total	Young pigs	Lean meat pigs	Fattened pigs
14,418,000	4,859,000	7,320,000	2,239,000

Source: as above

Table 4: Calculated requirements of concentrated feeds for pigs in 1984

Feed	1,000 Tons	Crude protein	
		%	1,000 tons
Maize	4,225	8.5	359
Barley and oats	325	9.5	31
Wheat bran	238.5	14	34
Dried skimmed milk	3	34	1
Fish meal	45	65	29.2
Meat meal	17	50	8.5
Soybean meal	410	44	180
Sunflower and rapeseed meal	100	30	30
Deshydrated lucerne meal	60	17	10.2
Total			682.9