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Alternatives to corn and soya-bean meal in feeding of layers : Yugoslavian experiments

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I. – Introduction

Following the development of animal production in Yugoslavia during the last 30 years, there have been fantastic developments in the poultry industry. From a primitive, small and scattered agricultural background, today's poultry production has been transformed into the art and reality of how specialized production can be at a high degree. Meat and egg production since 1960 has continually increased and has now developed into a large industry on farms with a high concentration of poultry that make use of modern scientific methods.

The annual growth in mass and eggs per layer has permanently increased and food conversion has improved because of high precision in meeting the exact demands for all nutrients. As a result, poultry is now the best way for transforming plant nutrients such as grains and plant proteins into proteins of animal origin which are essential for human nutrition.

This development of the poultry industry in Yugoslavia is mainly based on the use of nutrient mixtures in which corn is the basic energy source and soyabean meal the protein source. Yugoslavia is a big producer of grain corn (in 1986 corn production was 12 million tons) and a great amount of this feed is consumed in poultry nutrition. The concentration of metabolic energy per kilo of corn grain exceeds any other cereal and in this respect it remains as the most important energy source in poultry nutrition programmes.

The case is different with soyabean meal because soyabean is quite a new crop in Yugoslavia (in 1985 production was 185,000 tons) and current production is far below the normal needs of animal production. Soyabean is a very valuable protein feed for the nutrition of monogastric animals as it falls in the group of those feeds with a balanced amino acid content. Soyabean meal will remain as a fundamental protein feed but its production in Yugoslavia is limited so there is a need to find substitutes.

Regardless of the facts presented, there are numerous problems and difficulties providing poultry with basic feed. This results from increased production of meat and eggs, problems with the balance of payments, the dispersion of poultry farms in Yugoslavia, as well as limited knowledge and experience in the use of other local feeds produced as alternatives for corn and local soyabean meal.

Taking into consideration these problems, the aim of this paper is to describe the research already made on substitutes for corn and soyabean in the nutrition of layers and point out all that is important in the preparation of such mixtures.

II. – Alternatives for corn in the nutrition of layers

Substitutes to corn feed in Yugoslavia include barley which is grown in sufficient quantities in some regions (Macedonia) and sorghum whose production in arid regions is still beginning. Also wheat can substitute for corn even though it is now prohibited to use wheat as animal feed. These feeds, in their general nutrient value, are very close to corn but their energy value is significantly lower, especially with barley. Compensation of energy value in this situation can be easily achieved by using fat materials (from vegetable or animal origin) in a mixture where instead of corn there is barley or wheat as the basic energy source.

That is why experiments were conducted (Šokarovski *et al.*, 1972) to show the effect of corn, wheat and barley as energy sources in isocaloric and isoprotein mixtures on the performance of layers.

The composition and nutritive value of the mixtures used are shown in **Table 1** and the results in **Table 2.**

In this experiment on hens of hybrid Hy-Line kept in cages, mixtures were used in which the basic energy source was corn, barley, wheat or their combinations. The mixtures contained approximately 17% crude protein and about 11 MJ/ME/kg. The same caloric value in the mixtures was maintained by using vegetable fat that was 1% in the corn mixture and up to 6% in the barley mixture. The experiment was started when the hens reached 10% laying intensity.

From the data provided in **Table 2** it is clear that laying intensity in our conditions was at a high level in all groups, even though there were minor differences. The average mass on eggs was somewhat better in the group fed on corn (63 gr.) but in the other groups it remained approximately at the same level (60 - 61 gr.). Consumption of food per day and eggs produced were somewhat better in the groups where corn was substituted (with the exception of the group fed on wheat), and that could be explained by the specific effect of greater amount of fat used in the diet on production performances of layers. The consumption per kg of egg mass was almost identical in all groups except the one fed on wheat that consumed more feed.

In general, it was clear that wheat and barley can substitute corn in isocaloric mixtures without any negative effects on production performances of layers. Similar researches have been made in other countries especially in USA (Britzman, G.D., 1985). The achieved results in that particular work clearly confirm our own results.

III. – Alternatives for soyabean meal in our conditions

In Yugoslavia numerous crops are grown for oil production : soyabean, sunflower, rapeseed, pumpkins, ground nuts, linseed, ... For production of meals used as animal feed, the crops are : soyabean, sunflower and rapeseed.

Soyabean meal is a very valuable poultry feed. According to Yugoslav standard, it contains a minimum of 44% crude protein and a maximum of 7% crude fibre. Soyabean protein has a high biological value. In the last few years, there has been a great interest in soyabean production in Yugoslavia which approximated, in 1985, about 200,000 tons (Zlatić, H., 1986), which is far below the real needs for feeding domestic animals.

Taking into consideration this situation, it is of interest to find alternative solutions for soyabean in Yugoslavia. It can be concluded that sunflower and rapeseed can be successfully used as a substitute.

Sunflower meal is a valuable source of protein for poultry feed even though, form the point of view of nutrient content, it comes behind soyabean meal. The technology of production of sunflower meal allows for considerable remains of seed husks which reduce their protein value. According to Yugoslav standard,

this meal must have a minimum of 33.5% crude protein and an amount of crude fibre limited to a maximum of 18%. Characteristic of sunflower meal is the deficit in lysine but this deficiency can be corrected with a balanced protein diet. The high amount of cellulose in sunflower meal greatly limits wide use of this meal as an animal feed. Lately, efforts have been made to improve the technology of production of sunflower meal and hence sunflower meal present today on the market contains 44% crude protein and a greatly reduced crude fibre content in accordance with the standard. Annual production of this meal in Yugoslavia is 200,000 tons.

The extraction of oil from **rapeseed** has provided an animal feed that has found a great use as a protein addition to the diet of monogastric animals. The protein content is about 28-33% and, on the basis of the amino acid composition, rapeseed meal can be compared to soyabean meal. Soyabean meal contains more lysine than rapeseed meal but the opposite is true for methionine. Therefore, it is clear that these two meals are complementary, but the use of rapeseed meal is limited to low levels in poultry diet. High levels of this meal in the diets results in increase of mortality, increase in feed expenditure, reduced egg mass ; they also induce specific taint in shell-coloured eggs and increase the thyroid gland mass. The reason for all these negative effects is the presence of glucosinolates (thioglucosides) and erucic acid which are characteristic of old rapeseed varieties. Modern rapeseed varieties have low levels of these toxic materials and hence they can be used successfully as poultry feed.

According to some sources, an excess of 50,000 tons rapeseed meal is produced in Yugoslavia annually.

Taking into account the presence of the mentioned meals, i.e. sunflower and rapeseed, experiments were done in Macedonia to study the effect of substitution of soyabean meal by sunflower meal (Sokarovski *et al.*, 1972) on production performances and the possibilities of using rapeseed meal in layers nutrition (Abdul *et al.*, 1987).

In the first experiment, the aim of which was to confirm the effect of partial and complete substitution of soyabean meal by sunflower meal, mixtures were used the composition and nutritive value of which are given in **Table 3** and **Table 4**.

Hy-Line layers were used in this experiment conducted in cages. Three different mixtures were compared ; in the control diet (nb 1), the basic protein soyabean meal and, in experimental group 2, soyabean and sunflower meal in proportion 50:50. In experimental diet 3, there was complete substitution of soyabean by sunflower meal. Energy concentration as well as protein level were the same in all diets (energy equal to 11.4 MJ/ME/kg and protein 17%). The experiment began when intensity of laying was 10% and it went on for 370 days.

From the data reported in **Table 4** it is clear that laying intensity in all groups was quite good and the differences between experimental and control groups were unsignificant. Average egg weight was somewhat better with control group 1 (63 gr.) as compared to experimental groups 2 and 3 (60 and 61 gr.). Daily food consumption per produed egg and per kg egg mass was higher in group 3 which received no soyabean meal. Between control group 1 and experimental group 2 there was no visible difference for the above mentioned parameters.

An other experiment was conducted in order to examine the possibilities of using rapeseed meal as a layer meal. Four mixtures were used the composition of which is given in **Table 5.**

This experiment was done with Hisex hens kept in cages. Among the four mixtures compared, three were experimental (with rapeseed meal level from 2 to 6%) and one was a control in which 10% soyabean meal was present. All mixtures contained about 15 crude protein and about 11.5 MJ/ME/kg, meaning that they were isocaloric and isoproteinic. The experiment began when the hens were 28 week old, that is when their laying intensity was 75-78%, and lasted for 305 days.

From the results given in **Table 6**, it appears that laying intensity differed between different groups and the differences between control group 4 and experimental groups 1, 2 ans 3 were quite considerable. The best laying intensity was in the group fed on the highest percentage of rapeseed meal (6%). Significant differences in laying intensity were also apparent between the experimental groups and the groups fed on a high percentage of rapeseed meal. Average egg weight in experimental groups 2 and 3, and control group, was significantly lower compared to experimental group 1 which was treated with the lowest level of rapeseed meal.

Daily feed consumption and feed per produced egg were approximately the same in experimental groups 1 and 2 and in control group 4 while they were lower in group 3 receiving the highest amount of rapeseed meal. These results show that moderate levels of rapeseed meal in a diet can reduce the consumption of feed per day or per produced egg.

III. – Conclusion

In accordance with the data presented in this paper it is possible to conclude as follows:

I. Corn and soyabean meal remain the basic local feeds for layers in Yugoslavia.

II. As an alternative solution for corn in the present conditions, it is possible to use barley which, in isocaloric mixtures, gives almost satisfactory production results with layers.

III. Meals from sunflower and rapeseed can be substituted for soyabean meal in layer diets but in limited quantities because high levels have negative effects on feed efficiency (mainly sunflower meal).

Generally speaking, layers can be supplied with locally produced feeds in the future in Yugoslavia.

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Table 1: Composition and nutritive value of diets

Components, %	Mixture				
	1	2	3	4	5
	Corn	Wheat	Barley	Corn + Barley	Wheat + Barley
Corn	60.00	-	-	31.10	-
Wheat	-	61.91	-	-	32.70
Barley	-	-	58.00	28.00	26.45
Soyabean meal	15.15	11.15	12.15	13.65	11.50
Wheat brain	4.05	4.05	4.05	4.05	4.05
Fish meal	6.00	6.00	6.00	6.00	6.00
Alfalfa meal	4.00	4.00	4.00	4.00	4.00
Fat (vegetable)	1.00	3.00	6.00	3.50	5.00
Dicalcium phosphate	2.00	2.00	2.00	2.00	2.00
Limestone	7.00	7.00	7.00	7.00	7.00
Salt	0.30	0.30	0.30	0.30	0.30
Premix	0.50	0.50	0.50	0.50	0.50
L. Lysine	-	0.08	-	-	0.05
MJ/ME/kg	11.41	11.23	11.20	1.33	11.29
Crude protein	17.26	17.58	16.92	17.03	17.08
Crude fibre	3.97	4.05	5.74	4.83	4.79
Ca, %	3.55	3.56	3.56	3.56	3.56
P, %	0.84	0.86	0.87	0.87	0.86

Table 2: Effect of corn, wheat, barley and their combination on some production performances of layers

	Corn	Wheat	Barley	Corn + Barley	Wheat + Barley
Intensity of laying	71.6	72.3	73.1	73.6	73.4
Average weight egg	63.0	61.0	61.0	60.0	61.0
Consumption of food :					
– per day, g	114	117	110	110	112
– per egg, g	159	161	151	150	153
– per kg of egg mass, (kg)	2.50	2.63	2.47	2.50	2.50

Table 3: Composition and nutritive value of feeding mixtures

(Šokarovski *et al.*, 1972)

Components, %	Soyabean meal	Soyabean meal + Sunflower meal	Sunflower meal
Corn	60.00	58.90	57.30
Soyabean meal	15.15	7.60	-
Sunflower meal	-	7.60	15.15
Wheat bran	4.05	4.00	4.05
Fish meal	6.00	6.50	7.00
Alfalfa meal	4.00	4.00	4.00
Fat (oil)	1.00	1.50	2.50
Dicalcium phosphate	2.00	2.00	2.00
Limestone	7.00	7.00	7.00
Salt	0.30	0.30	0.30
Premix	0.50	0.50	0.50
Lysine		0.10	0.20
MJ/ME/kg	11.42	11.35	11.35
Crude protein (%)	17.26	16.96	16.61
Crude fibre (%)	3.97	4.47	4.96

Table 4: Effect of substitution of soyabean meal by sunflower meal on some production performances of layers

Components, %	Mixture		
	1	2	3
	Soyabean meal	Soyabean + Sunflower meal	Sunflower meal
Intensity of laying	71.6	73.7	73.11
Average egg weight	63	60	61
Consumption of food :			
– per day, g	114	112	122
– per egg, g	159	152	167
– per kg of egg mass, kg	2.50	2.54	2.71

Table 5: Composition and nutritive value of diets

(Abdul *et al.*)

Group / Components %	Rapeseed Meal Incorporation			
	2 %	4 %	6 %	0 %
Corn	67.68	67.55	67.48	67.70
Soyabean meal	8.00	6.83	6.06	10.00
Sunflower meal	10.00	9.64	8.57	10.00
Rapeseed meal	2.00	4.00	6.00	-
Fish meal	3,00	3.00	3.00	3.00
Wheat brain	0.40	-	-	-
Limestone	7.20	7.20	7.18	6.50
Dicalcium phosphate	1.15	1.23	1.10	2.00
Salt	0.15	0.15	0.15	0.15
Premix	0.50	0.50	0.50	0.50
MJ/ME/kg	11.72	11.68	11.57	11.49
Crude protein (%)	14.87	14.87	15.00	15.07
Crude fibre (%)	4.65	4.68	4.67	4.78
Ca, %	2.73	2.80	2.62	2.21
P, %	0.70	0.68	0.64	0.68

Table 6: Effect of diets with different quantities of rapeseed meal on some production performances of layers (Abdul *et al.*, 1987)

	2 % Rapeseed meal	2 % Rapeseed meal	2 % Rapeseed meal	2 % Rapeseed meal
Intensity of laying	70.10	71.50	73.0	67
Average egg weight	61.00	58.00	58.0	57
Consumption of food :				
– per day, g	125.00	123.00	116.0	123
– per egg, g	178.00	173.00	158.0	185