THE EFFECT OF DRIED FRUIT-VEGETABLE-HERB CONCENTRATE APPLIED IN COMPOUND FEED-STUFFS ON REPRODUCTIVE PERFORMANCE OF BROILER CHICKEN PARENT STOCK

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Abstract. The study aimed at evaluating the effect of phytobiotic from waste products being obtained in fruit, vegetable and herb processing on the performance and hatchability rates of broiler chicken breeder hens. The study material consisted of a group of ROSS 308 broiler chicken breeders, numbering 9900 birds. The control (group 1) was fed a standard feed, whereas experimental groups 2 and 3 were given the standard feed being supplemented with dried fruit-vegetable-herb concentrate in the amount of 1.5 and 3%, respectively. During the experiment, the following parameters were recorded: body weight, feed consumption, number of eggs per layer, egg weight, deaths and culling related to health problems. Based on the data being obtained from 70 experimental incubations, egg fertilisation and chick hatchability rates were calculated. Dried fruit-vegetable-herb concentrate favourably affected the final body weight of layers, decreased the mortality of hens and cocks, as well as induced an increase in the number and weight of eggs. An improvement in reproduction parameters was demonstrated, being expressed in higher fertilisation and hatchability rates. Feed consumption per egg gradually decreased together with an increase in the level of dried fruit-vegetable-herb concentrate in feed.

Keywords: dried fruit-vegetable-herb concentrate, health state, reproduction parameters

Introduction. For many years, research has been carried out to improve reproductive indices as well as quality of obtained products by modification of the composition of compound feed-stuffs being applied in chicken nutrition. At present, a common practice is to use natural immunostimulants of plant origin. They can boost organism resistance to diseases, control blood pressure and affect blood biochemical parameters, as well as modify the qualitative and quantitative composition of gastrointestinal tract micro-flora (Majewska et al., 2007; Dieumou et al., 2009; Prasad et al., 2009; Teymouri et al., 2009; Skomorucha et al., 2012). The studies being carried out so far on the effect of compound feed-stuffs with addition of phytobiotics in poultry nutrition show their favourable effects on production parameters (Mansoori et al., 2008), hatchability rates and fertilisation (Bozkurt et al., 2009), slaughter traits (Czaja and Gornowicz, 2004) and raw product quality (Chowdhury et al., 2002; Olobatoke and Mulugeta, 2011; Połtowicz and Doktor, 2012). During fruit and vegetable processing, pomaces are being obtained, among other things that contain many valuable constituents which can be used for feed purposes. They are a valuable source, among others, of pectin compounds, waxes or other specific functional constituents. The findings of Ayhan and Aktan (2004) demonstrated possibilities of applying this supplement in the nutrition of broiler chickens with no negative effect on their production indices and survival rates. On the other hand, Ghazi and Drakhshan (2006) did not observe any significant differences in the body weight gains and breast muscle, liver and gizzard weights in broiler chicks being fed a diet with 5, 10 and 15% tomato waste. Mansoori et al. (2008) found that administration of a compound feed-stuff with 10% tomato pomace to laying hens improved their egg production and egg quality. Dried apple pomace is a by-product being obtained during the processing of apples into juice and wine. It comprises apple peel residues, cores and structural carbohydrates, primarily pectin. By binding bile salts, pectins can reduce cholesterol resorption and decrease its levels in blood as well as in eggs. Some authors believe that 5-10% supplement of dried apple pomace to broiler chicken diet as a corn replacement does not affect their production indices (Zafar et al., 2005; Ayhan et al., 2009). The studies being carried until now on the effect of compound feed-stuffs with addition of phytobiotics in poultry nutrition show their favourable effects but the size of their dose has been not clearly determined yet.

The present study aimed at evaluating the effect of phytobiotic from waste products being obtained in fruit, vegetable and herb processing as a supplement to compound feed-stuffs on reproductive indices of broiler chicken breeders. Taking into consideration the fact that dried fruit-vegetable-herb concentrates are a source of many substances with high biological potential, the authors assumed an improvement in the health state, fertilisation and hatchability rates.

Material and methods

The study material consisted of a group of ROSS 308 broiler chicken breeders, numbering 9900 birds. Before experiment, hens and cocks were weighed and divided into three groups. Hens of respective groups were kept in separate buildings of different area. Group sizes were

adjusted to the area of a given building, assuming 7 birds per 1 m^2 of the floor area. Each building was provided with similar feeding, watering equipment and automatic community nests. Control group (group 1) numbered 3500 hens and 350 cocks, while experimental groups 2 and 3 included 2600 hens and 260 cocks and 2900 hens and 290 cocks, respectively. Hens were kept on straw bedding under controlled environmental conditions conforming to the requirements of proper management of birds of this line. The study was carried out for 35 weeks, from 26 to 60 weeks of age. The control group was fed a standard complete feed intended for the time of laying production with the nutritive value being recommended in the ROSS Parent Stock Management Manual was fed to birds (Tables 1 and 2). The hens of experimental groups 2 and 3 were given a compound feed-stuff with a 1.5 and 3% addition of dried fruit-vegetable-herb concentrate, respectively.

Table 1. **Composition of compound feed-stuff for adult broiler chickens** (%)

Compound feed-stuff constituents	Percentage
Ground wheat	33.60
Ground corn	35.00
Wheat bran	2.70
Post-extraction soybean meal 46%	20.00
Soybean oil	0.30
Monocalcium phosphate	0.85
Coarse-grained fodder chalk	5.70
NaCl	0.28
Humokarbowit®*	0.50
Lutamix® DJ-R 1%**	1.00
DL-methionine	0.07
*Humokarbowit – including humic acids and their salts, bitumens, hemicellulose, lignin, wax, resins, phytohormones, phytoenzymes, proteins and amino acids, polysacharides and a wide range of macro- and microelements **Lutamix , supplied to 1 kg of diet: IU: vit. A 10 000; vit. D3 3000; mg: K3 2; B1 1; B2 4; B6 1.5; B12 0.01; Ca-pantotenate 8; niacine 25; folic acid 0.5; choline-Cl 250; Mn 100; Zn 50; Fe 50; Cu 8; J 0.8; Se 0.2 and Co 0.2	

Table 2. **Chemical composition of compound feed-stuff** (%)

Chemical composition	Percentage
Dry matter	87.11
Metabolisable energy MJ/kg	11.51
Total protein	16.01
Crude fibre	3.14
Ash	9.97
Vitamin A IU	13500.0
Vitamin D3 IU	3000.0
Vitamin E mg	47.50

This dried concentrate, with the trade name KN (Nutritive Plant Concentrate KN for Layers) comprised: apple pomace (25%), choke-berry pomace (20%), strawberry pomace (10%), black-currant pomace (25%), tomato pomace (5%) and dried parsley (5%), dried nettle (5%) and dried lemon balm (5%). Basic chemical composition of the plant concentrate under evaluation was determined by conventional methods (Tab. 3). These data were used to balance experimental compound feed-stuffs, the nutritional value of which was similar to that of the compound feed-stuff for the control group.

Table 3. **Chemical composition of plant concentrate** (%)

Item	Percentage
Dry matter	90.4
Total protein	8.2
Crude fibre	17.8
Crude fat	5.7
Ash	5.2

Hens and cocks were on restricted feeding, being given strictly weighed daily feed rations. During the experiment, the following parameters were recorded: body weight, feed consumption, number of eggs per layer, number of hatching eggs per layer, egg weight, deaths and culling related to health problems. Based on them, production indices were calculated (in relation to the average layer stock), i.e. feed consumption per egg and hatching egg, percentage of laying performance, number of eggs and hatching eggs per layer, and percentage of losses. After the initial evaluation, eggs were sent to a hatchery twice a week, starting from 26 weeks of age. Hatches were performed in HatchTech hall incubators.

During the experiment, 70 egg settings were made, in which the following parameters were determined: number of unfertilised eggs, size of hatchery waste (dead embryos, unhatched and crippled chicks), and number of hatched chicks. Based on the data being obtained, fertilisation and hatching rates from the set and the fertilised eggs were determined, as well as the number of chicks per hen of the initial and the average layer stock. The results were processed statistically using STATISTICA ver. 9D computer software package.

Results. In the first week of the experiment, the body weight of hens (Table 4) was equalised across all groups and ranged from 2200 g (group 1) to 2230 g (group 3). Mean body weight of cocks amounted to 2910 g. Body weight equalisation in both sexes was a methodological assumption.

In the final stage of the experiment, the highest body weight was observed in the hens of group 3 (3605 g), while the lowest one in those of group 1 (3494 g). The differences between these groups (3.2%) proved to be statistically significant. The body weight of cocks at 60 weeks of age was similar and amounted on average to 4355.0 g (Table 4.). Hen mortality and culling rates in groups 2 and 3 were lower by 1.3 and 1.5%, respectively, which constituted 68.6% and 64.7% of all deaths being recorded in the control group (Table 4.). The lowest mortality of cocks was observed in group 3 (8%), whereas the highest one in group 1 (11.4%) (Table 4).

Table 4. **Body weight and health state in broiler chicken breeder flock. Explanations**: mean in the same line marked: A, B – differences statistically significant at P≤0.01

Item		Groups		
		1	2	3
Body weight of hens (g)	20 weeks of age	2200.0±161.0	2205.0±163.0	2230.0±167.0
	60 weeks of age	3494.0A±155.0	3560.0±143.0	3605.0B±155.0
Body weight of cocks (g)	20 weeks of age	2911.0±197.0	2910.0±185.0	2905.0±192.0
	60 weeks of age	4355.0±307.0	4355.0±306.0	4354.0±308.0
Hen mortality and culling	%	4.37	3.00	2.83
Cock mortality and culling	%	11.43	10.38	8.62

The most eggs per layer (181 eggs) were obtained in group 3. The laying performance of hens in the control group in the time under analysis amounted on average to 71.5%. Introduction of dried fruit-vegetable-herb concentrate induced an increase in the laying performance percentage to 72.6% (group 2) and 74.1% (group 3). A dried fruit-vegetable-herb concentrate addition also positively affected the number of hatching eggs being obtained per layer. When compared to the control group, this represented an increase by about 1.6 and 4%, respectively. The egg weight was controlled for 35 weeks of the experiment. In groups 1 and 2, the egg weight was similar and amounted to about 61 g, while in group 3 it increased to 63.3 g (Table 5). The mean weight of hatching egg ranged from 62.5 g (group 1) to 64.9 g (group 3). An almost 4% increase in the weight of hatching eggs from the hens of the group being fed a diet with higher percentage of dried fruit-vegetable-herb concentrate in relation to group 1 and a 3% one in relation to group 2 was statistically significant at P≤0.01.

Table 5. **Hen laying performance indices. Explanations: mean in the same line marked:** A, B – differences statistically significant at P≤0.01

Item		Groups		
		1	2	3
Laying performance from 26 to 60 weeks of age	%	71.5±.11.3	72.6±11.2	74.1±11.2
	eggs/hen	175.18±16.8	177.87±16.1	181.55±17.3
Percentage of hatching eggs	%	94.06±3.86	94.19±3.66	94.70±3.57
	eggs/hen	164.84±14.28	167.54±14.73	171.44±15.01
Egg weight	g	61.1A±4.0	61.6A±4.2	63.3B±4.6
Hatching egg weight	g	62.5A±4.2	63.0A±4.5	64.9B±4.6

The consumption of compound feed-stuff per layer amounted on average to about 39 kilograms in all groups. Similar consumption resulted from restricted feeding and other uniformly acting factors affecting it.

Feed consumption per egg in the control group amounted to 223.8 g (Table 6). As the percentage of experimental factor in diet increased, feed consumption gradually decreased, reaching its lowest level in group 3 (212.9 g). However, the statistical analysis of data did not show any significance of differences. In group 3, feed consumption per egg decreased by almost 5%. The lowest feed consumption per hatching egg (by more than 5%) was also a characteristic of group 3 (225.51 g), with 237.8 g in the control group (Table 6).

Table 6. **Feed consumption**

Item		Groups		
		1	2	3
Daily feed intake	g/layer	160.0±7.6	158.0±7.6	157.8±7.5
Feed consumption	g/egg	223.77±30.4	217.63±28.8	212.95±27.5
Feed consumption	g/hatching egg	237.81±43.1	231.05±38.9	225.51±36.9

The most satisfactory fertilisation rate was observed in group 3 (90.7%), whereas the least favourable one in group 1 (86.8%). The lowest percentage of unfertilised eggs (9.3%), as well as that of hatchery waste (15.1%), was found in group 3, with 13.2 and 19.4%, respectively, in the control group (Table 7). The best hatchability rate was found in the group with a 3% addition of dried fruit-vegetable-herb concentrate. Mean hatching percentage from the set and the fertilised eggs in this group amounted to 84.2 and 92.9%, respectively. In group 2, these rates were lower by about 3.5 and 2%, respectively. The lowest hatching rate, from both the set and the fertilised eggs, was obtained in the control group (76.5 and 88.2%, respectively) (Table 7). These differences between respective groups were statistically significant. The greatest number of chicks, in relation to the average and the initial layer stock, was obtained from the hens of group 3.

Table 7. **Egg fertilisation and hatchability rates. Explanations: mean in the same line marked:** A, B, C – differences statistically significant at P≤0.01

Item		Groups		
		1	2	3
Number of set eggs	n	564330	429070	490147
Number of unfertilised eggs	n	74492	47627	45584
	%	13.20	11.10	9.30
Number of fertilised eggs	n	489838	381443	444563
Fertilisation rate	%	86.80A±3.0	88.90B±2.9	90.70C±2.3
Number of healthy hatched chicks	n	432037	346350	412999
Hatchery waste (dead embryos, unhatched and crippled chicks)	n	57801	35093	31564
	%	19.42A	17.60a	15.13Bb
Hatchability from set eggs	%	76.56A±3.0	80.72±2.9	84.26±2.3
Hatchability from fertilised eggs	%	88.20A±2.2	90.80B±2.3	92.90C±2.1
Number of chicks per hen of:	Average layer stock	126.20	135.20	144.40
	Initial layer stock	123.4	133.20	142.40

Discussion. Considering the lack of papers on the effect of fruit-vegetable-herb concentrate on reproductive parameters in chicken as well as in poultry being managed under other lines of production, the results of this study cannot be properly referred to any of them. The results being obtained for groups 2 and 3, in which the hens were given an experimental factor in the amount of 1.5 and 3.0%, respectively, may be characterised against the data for the control group being fed a standard diet (which has been done in "Results") and compared with the findings of experiments with plants containing different biologically active substances.

In the study by Hernandez et al. (2004), a positive effect of herbal extracts on improvement of compound feed-stuff digestibility and slaughter yield in broiler chickens was demonstrated. The study by Mikulski et al. (2008), being carried on slaughter turkeys using diets with addition of herbal and fruit essential oils and organic acids, confirmed their positive effect on the body weight. These authors also found a lower feed consumption, by 2.4–5.3%, in the turkey groups being fed a compound feed-stuff containing analysed supplements when compared to the control group. Bozkurt et al. (2009), using a diet with addition of herbal essential oils in the feeding of broiler chicken breeders, obtained higher egg fertilisation and hatchability rates. In practice, the most frequently used criterion of poultry fertility is the percentage of fertilised eggs and the number of chicks obtained from one female. The fertilisation results depend to a similar extent on males and females. The effect of male primarily depends on sperm quality, whereas that of female on enabling physiologically the oviduct to preserve sperm viability and motility as long as possible. Seeds of some fruits, as well as vegetables, are a source of tocopherols, fatty acids and certain chemical elements that affect reproduction. Linoleic acid takes part in development of testicles and spermatogenesis and affects FSH and LH levels. Chemical elements being of the greatest importance in sperm formation and quality include Zn, Se and Mn (Gallo et al., 2003; Surai, 2002). Selenium deficiency lowers the sperm quality through disturbances in the formation of sperm middle piece. The level of zinc and calcium ions and vitamins C and E prevent peroxidation of plasma membrane lipids of the spermatozoa stored in sperm storage tubules (SST) being found in laying hen oviduct.

The findings referring to the effect of diet with black cumin on the body weight and feed consumption in poultry are ambiguous. In the studies conducted by Akhtar et al. (2003), a decrease in the body weight of chickens being fed a compound feed-stuff with this experimental supplement was observed. On the other hand, El-Bagir et al. (2006) found an increase in the final body weight of laying hens and a decrease in feed consumption per 1 kg eggs. They also showed a significant increase in the laying production, egg weight, eggshell quality and a decrease in the cholesterol concentration in egg yolks. The results of experiment by Szczerbińska et al. (2012), with the use of diet being enriched with black cumin seeds, show a favourable effect of this constituent on the laying performance and hatchability from fertilised eggs of Japanese quails. The study conducted by Majewska et al. (2007) with water extracts of fresh garlic being added to drinking water for slaughter turkeys showed a considerably lower mortality rate, with higher body weight, by 1.3%, and lower feed conversion ratio, by 3.1%, in relation to the control group. The authors mentioned above are of the opinion that the experimental factor being applied also positively affected some blood parameters. The results of studies by Teymouri Zadeh et al. (2009) and Jafari et al. (2011) coincide with this finding. On the other hand, Prasad et al. (2009) are of the opinion that garlic supplementation does not have any considerable effect on blood parameters. This is because they observed insignificantly lower Hb and TEC values in the chicken groups with garlic diet. Chowdhury et al. (2002), when feeding a compound feed-stuff with dried garlic paste to laying hens, did not observe any negative effect of this diet on muscle percentage, egg shape and egg content weight. Olobatoke

and Mulugeta (2011), based on the results of experiments determining the effect of garlic powder on layer production efficiency, health and egg quality, observed a significant increase in the albumen height and the Haugh units in the eggs of layers being fed a diet with a 3% garlic powder addition. In the group of layers being fed a compound feed-stuff with a 5% garlic powder addition, egg production decreased, probably, due to a decrease in feed consumption. Results of egg organoleptic evaluation showed a strong garlic flavour in the eggs of layers being fed a diet with higher garlic powder level. Cross et al. (2011) found that the growth rate of broiler chickens fed on diet with garlic supplement was on the increase but only in the initial period of fattening. The efficiency of apple pomace application in the nutrition of broiler chickens was evaluated in some studies. In the study by Zafar et al. (2005) on broiler chickens, the group receiving apple pomace in its diet obtained higher body weight in 6 weeks of age but this difference proved to be statistically non-significant. Ayhan et al. (2009) did not observed any differences in feed consumption in 6-week-old broiler chickens. However, the authors mentioned above are of the opinion that apple pomace can be applied as a source of energy in a feed ration for broiler chickens in an amount not exceeding 10% in partial replacement for corn. According to them, higher level of this feed additive may create a problem of wet bedding and decrease feed consumption due to high fibre content. Leusink et al. (2010), when using cranberry fruit extract in the nutrition of broiler chickens, did not observe any significantly favourable results in their fattening. However, these authors are of the opinion that constituents of those fruits help improve the bird health and may be used in safe food production. This is because fruit pomace, as well as vegetable pomace, contains many compounds with strong antioxidant activity, mainly polyphenols. Natural antioxidants constitute an effective protection of cells against the attack of free radicals, which helps prevent many diseases (Tarko et al., 2012). In literature, there are also studies on the application of tomato pomace in poultry feeding. Ayhan and Aktan (2004) did not observed any statistically significant differences in the body weight and feed consumption between the control group and the experimental one when feeding broiler chickens with a diet containing a 5% addition of dried tomato pomace. The broiler chickens of the group obtaining 10 and 15% additions of dried waste from tomato puree production were characterised by lower body weight in 6 weeks of age. Ghazi and Drakhshan (2006), when replacing soybean with tomato pomace in the amount of 5, 10 and 15%, did not observed any statistically significant differences in the body weight and feed consumption in broiler chicks or in the percentage of breast muscles, liver and gizzard and abdominal fat. The study on Japanese quails being kept at elevated temperature with feeding with dried tomato pomace showed increased feed consumption but also better body weight gains. It was also proved that dried tomato powder decreased negative effects of heat stress (Sahin et al., 2008). In the experiment being performed on laying hens with 5 and 10% of tomato pomace as a substitute for wheat bran, Mansoori et al. (2008) found that this experimental factor had a positive effect on the yield of egg production and egg quality. These authors are of the opinion that tomato pomace is a good source of protein and vitamins as well as is reach in carotenoids, which affects egg yolk colour.

Conclusions

In the groups fed compound feed-stuffs with a 1.5 and 3% addition of dried fruit-vegetable-herb concentrate, the number and the weight of hatching eggs increased. Higher fertilisation and hatchability rates were also observed. The feed consumption per egg and hen and cock mortality decreased with an increase in the level of dried concentrate in diet.

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