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Effects of Bee Pollen on the Technical and Allocative Efficiency of Meat Production of Ross 308 Broiler

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Abstract: Productivity and efficiency are the most important aspects helpful in making decisions about production and selection of inputs. Ultimately, the most efficient production ensures more profit of any business. The business of chicken production is one of the profit earning businesses. The sustainability which ensures the existence of the firms as well as promises the availability of food and fiber depends on the efficient use of input puddles. With reference to cost minimization and profit maximization, poultry feed which takes the major portion of the total cost is extremely important. This research was done to see the effects of bee pollen on the poultry meat production efficiency (technical as well as allocative efficiency). On the basis of data of input quantities (feed) and output quantities (meat of different parts of chicken), technical efficiency was measured. Additionally, in order to see the allocative efficiency, prices of inputs (feed) and outputs (each part of chicken meat) were considered. After analyzing the average efficiency scores, it was found that group P1 of chicken which was supplemented with bee pollen as 5g kg^{-1} of feed mixture, got the maximum average efficiency scores as 0.9732 and the control group (K) got the 2nd level. It was concluded that use of bee pollen has limited positive effect i.e., use of bee pollen 5 g kg^{-1} of feed mixture has positive effect and when its use is more than 5 g kg^{-1} of feed mixture then its effect is negative. As the amount of bee pollen is increased, the average efficiency score decreases continuously.

Key words: Bee pollen, feed mixture, productivity, technical efficiency, allocative efficiency

INTRODUCTION

The researchers have contributed a lot to indicate the key measures in terms of efficiency and productivity of different forms of business. Most of these studies have focussed over Technical Efficiency (TE) and Allocative Efficiency (AE). AE is measured in terms of Cost Efficiency (CE), Revenue Efficiency (RE) and Profit Efficiency (PE). The purpose of all of these measures is to get on the best decision while keeping the objectives of business in mind. These measures are correlated with the different indicators such as farm size, quantities and types of inputs, environmental factors which can be controlled by the managers. In literature, we may find a number of studies which have shared their findings in terms of productivity in relation with the farm size, type and quantities of inputs. For example: Aslan *et al*. (2007) conducted a study to investigate the effects of propolis and mesal amine on experimental colitis in rats and concluded that propolis and mesal amine are efficient independently but their combined effect was not observed to be additive in experimental colitis. On the other hand, Asikgoz *et al*. (2005) conducted a study to investigate the effect of propolis on the body weight and feed intake and feed conversion on the male chicken of Ross 308. The author concluded that propolis had adverse effect on feed intake as well as body weight. The propolis that was collected from the pine trees has a strict genuine odour, volatile compounds and bitter taste; these characteristics of pine-propolis may have caused the broilers to reject the feed or affected negatively their desire for the diet. The use of propolis in the poultry feed stems from the idea from the studies which concluded that the antibiotics which have been used in the past in the poultry feed had negative effects on the human health. Therefore, the studies, now a days have focused to search some natural material instead of antibiotics in the diet (Asikgoz *et al*., 2005). To get more information on this topic see (Hegazi and Abd El Hady, 1994, 1999; Stangaciu, 1999; Muntedt and Zygmunt, 2002).

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Seven (2008) conducted a study to see the effects of propolis and vitamin C (L-ascorbic acid) supplementation in diets which were investigated on Feed Intake (FI), Body Weight (BW), Body Weight Gain (BWG), Feed Conversion Rate (FCR) and digestibility and on egg production and qualities (weight, mortality, shell thickness) in laying hens exposed to heat stress. The author concluded that the simultaneous dietary supplementation with vitamin C and two different doses (2 and 5 g kg^{-1} diet supplementation) of propolis for laying hens exposed to heat stress significantly improved performance (increase in FCR and BWG), egg qualities (production, weight, shape index, yolk index, albumen index, haugh unit, shell thickness, egg shell weight) and nutrient digestibility. Shalmany and Shivazad (2006) conducted a study to investigate the effects of Alcoholic Extract of Propolis (AEP) on Ross 308 performance and concluded that average weight gain, feed consumption, feed efficiency were significantly higher for propolis fed birds and inclusion of propolis also reduced mortality rate in comparison to control diet. Simsilarly, Heindl *et al.* (2010) conducted a series of experiments to see the effects of dietary selenium sources and levels on performance, selenium content in muscle and glutathione peroxidase activity in broiler. The author concluded that less selenium is maintained in chicken tissues when the inorganic form of selenium is used as compared to the organic selenium source. The results also showed the identical effect of Sel-plex (SP) and selenium-enriched alga chlorella (SCH) in broiler; sodium selenite at both levels of 0.15 and 0.30 mg of Se kg^{-1} in diets may have the same effect and the organic selenium supplement (SP, SCH) was effectively absorbed into muscles of chicken contrary to Sodium Selenite (SS). The studies supporting to these results may be consulted for detail as Cantor *et al.* (1982), Hassan *et al.* (1988), Spears *et al.* (2003), Dlouhá *et al.* (2008).

The objective of the current study was to measure the technical and allocative efficiency of the chicken grown up with additive quantities of bee pollen so that we may make the decision in choosing the best alternative of poultry farming.

MATERIALS AND METHODS

The experiment was conducted at poultry test station of Slovak University of Agriculture in Nitra, Slovakia. The breed of tested chicken was Ross 308. This experiment was conducted on December 06, 2011 to January 16, 2012. As our purpose of the study was to find out the best group of the chicken fed with different ratios of bee pollen. Therefore, in total, 6 experimental groups of broiler Ross 308 were grown up with different combinations of feed mixture (Table 7) and bee pollen (Table 8). Each group had 10 chicken. All of the six experimental groups (K, P1, P2, P3, P4 and P5) were fed with the starter and grower feed having 0, 5, 15, 25, 35 and 45 g kg^{-1} of feed mixture, respectively. Data was collected against the two inputs (weights of starter feed and grower feed) and six outputs (weights of carcas, thighs, breast, liver, gastric and heart). Detail of the outputs for each chick is given in Table 10 in appendix. For the inputs, average quantities of feed (Table 9) taken by each chick was calculated with in each group individually whereas output weights were recorded for each chick after slaughtering. On the basis of these data, statistical analysis; technical as well as allocative efficiency scores were measured for each chick by using Data Envelopment Analysis (DEA) models. The technical efficiency was calculated by using nonracial, input oriented, variable return to scale-free disposal hull (VRS-FDH) as well as Scale Constant Returns to Scale (CRS and VRS) DEA models. Similarly, all of the allocative efficiencies (cost and revenue) measures were calculated by considering VRS-FDH as well as Scale (CRS and VRS) models. Here, the profit efficiency measures were not included as the cost efficiency measures and revenue efficiency measures also ensure the profit efficiencies. Therefore, in total six types of efficiency scores were calculated for each chick which are given under.

Technical efficiencies:

- Input oriented VRS-FDH
- Input oriented Scale (CRS and VRS)

Allocative efficiencies:

- Cost-VRS-FDH
- Cost-Scale (CRS and VRS)
- Revenue- VRS-FDH
- Revenue-Scale (CRS and VRS)

These six types of efficiency ensure (1) the minimum use of inputs while ensuring the maximum feasible level of output (2) cost minimization and (3) revenue maximization. In case of technical efficiency measures we consider only the input and output quantities whereas in case of allocative efficiencies, the prices of both inputs as well as outputs (Table 12) were also considered. Therefore, the chicken which show the maximum efficiency scores in these efficiency measures also ensure the maximum profit. For detail about the DEA models used here, please see (Lovell, 1993; Sadoulet and Janvry, 1995; Charnes *et al.*, 1978; Coelli *et al.*, 1998; Banker *et al.*, 1984). The results gained for the efficiency measures are given in the (Table 11).

After analyzing the efficiency measures, the average efficiency scores (average of all of the six types of efficiency measures), shown in Table 11 and total meat weight (sum of all six economic parts of the chick meat), shown in Table 10, were calculated for each chick and then a statistical analysis (group correlation analysis) was taken by using SAS software. Total meat weight of all economic parts of the each chick was considered as analysis variable and it was correlated with the average efficiency scores of each chick. After analysis we found the results which are discussed in the following section.

RESULTS AND DISCUSSION

As described before we calculated the average efficiency measures and total weights of six economic parts of the chicken and then took the correlation analysis by groups. The results of each group are given Table 1-6.

The Table 1-6 show very important results. The two important variables given in these tables are average efficiency scores and the total meat weight that is the weight of all six economic parts of the chicken meat. The results of experiment and its analysis show very clearly that: (1) With the use of bee pollen in the feed mixture of chicken, the average feed intake decreases and it goes on decreasing if more amount of bee pollen is added. The results are shown in the Table 9. These results are similar to the findings by Asikgoz *et al.* (2005) which are discussed in the introduction too. (2) With the use of bee pollen, the average meat weight of the experimental groups also decreases and it goes on decreasing as the amount of been pollen is added more. These results are shown in the Table 1-6. (3) Average efficiency scores increase only when we use

Table 1: Group K

Simple statistics

Variable	N	Mean	Std. Dev.	Sum	Minimum	Maximum
Ave. efficiency	10	0.96597	0.02112	9.65967	0.93200	0.98733
Meat weight	10	2222	106.20645	22223	2036	2342

Table 2: Group P1

Simple statistics

Variable	N	Mean	Std. Dev.	Sum	Minimum	Maximum
Ave. efficiency	10	0.97320	0.02148	9.73200	0.94100	0.99400
Meat weight	10	2188	144.97111	21883	1952	2352

Table 3: Group P2

Simple statistics

Variable	N	Mean	Std. Dev.	Sum	Minimum	Maximum
Ave. efficiency	10	0.95520	0.03184	9.55200	0.90450	1.00000
Meat weight	10	2147	186.57432	21474	1926	2474

Table 4: Group P3

Simple statistics

Variable	N	Mean	Std. Dev.	Sum	Minimum	Maximum
Ave. efficiency	10	0.94507	0.03237	9.45067	0.88917	0.98667
Meat weight	10	2111	131.04647	21109	1890	2304

Table 5: Group P4

Simple statistics

Variable	N	Mean	Std. Dev.	Sum	Minimum	Maximum
Ave. efficiency	10	0.94225	0.02980	9.42250	0.90283	0.98483
Meat weight	10	2141	113.97528	21410	1972	2309

Table 6: Group P5

Simple statistics

Variable	N	Mean	Std. Dev.	Sum	Minimum	Maximum
Ave. efficiency	10	0.93948	0.02844	9.39483	0.87183	0.97050
Meat weight	10	1959	140.55904	19593	1636	2137

Table 7: Composition of the diets

Ingredients (%)	Starter (1 to 21 days of age)	Grower (22 to 42 days of age)
Wheat	35.00	35.00
Maize	35.00	40.00
Soybean meal (48 % N)	21.30	18.70
Fish meal (71 % N)	3.80	2.00
Dried blood	1.25	1.25
Ground limestone	1.00	1.05
Monocalcium phosphate	1.00	0.70
Fodder salt	0.10	0.15
Sodium bicarbonate	0.15	0.20
Lysin	0.05	0.07
Methionine	0.15	0.22
Palm kernel oil Bergafat	0.70	0.16
Premix Euromix BR 0, 5 %[1]	0.50	0.50
Analysed composition (g kg^{-1})		
Crude protein	210.76	190.42
Fibre	30.19	29.93
Ash	24.24	19.94
Ca	8.16	7.28
P	6.76	5.71
Mg	1.41	1.36
Linoleic acid	13.51	14.19
MEN (MJ kg^{-1})		
by calculation	12.02	12.03

[1]active substances per kg of premix: Vitamin A 2 500 000 IU; vitamin E 50 000 mg; vitamin D_3 800 000 IU; niacin 12 000 mg; d-pantothenic acid 3 000 mg; riboflavin 1 800 mg; pyridoxine I 200 mg; thiamine 600 mg; menadione 800 mg; ascorbic acid 50000 mg; folic acid 400 mg; biotin 40 mg; vitamin B_{12} 10.0 mg; choline 100 000 mg; betaine 50 000 mg; Mn 20 000 mg; Zn 16 000 mg; Fe 14 000 mg; Cu 2 400 mg; Co 80 mg; I 200 mg; Se 50 mg

bee pollen (5 g kg^{-1}) of feed mixture but the average efficiency scores go on decreasing as we in crease the amount of bee pollen above (5 g kg^{-1}) of feed mixture. Although, the total weight of the economic parts is important but our decision lies on those combination inputs and outputs which have more profit insurance. Therefore, the group which have more mean value of average efficiency scores is the best one. It is clear from the results that group-P1 is the best of all as it got the mean value of average efficiency score as 0.9732 (the maximum). Group K, although got maximum mean value of meat weight (2222 gm) but its mean value for average efficiency score (0.9660) is lesser than that of group-P1.

Table 8: Bee pollen per kg of diet

Experiment groups	Bee pollens (gm)
K	0
P1	5
P2	15
P3	25
P4	35
P5	45

Table 9: Inputs weights (average feed taken (g) by each chick with in the group)

DMUs	Input-1 Starter (1-21 days of age)	Input-2 Grower (22-42 days of age)
K	847.3267	3201.593
P1	780.4367	3109.167
P2	768.5733	3173.133
P3	771.2167	3192.877
P4	809.4367	3217.33
P5	751.7033	3056.35

Table 10: Output weights (gm)

Data measurement units (DMUs)	Carcas (gm)	Thighs (gm)	Breast (gm)	Liver (gm)	Gastric (gm)	Heart (gm)	Total weights (gm)
K 0	1682	238.71	262.92	47.34	21.23	13.45	2265.65
K 1	1680	224.52	312.65	37.86	25.01	09.01	2289.05
K 2	1717	253.61	289.42	43.34	23.93	10.69	2337.99
K 3	1753	238.81	264.42	50.67	23.71	11.19	2341.8
K 4	1717	226.1	303.02	38.96	24.72	11.44	2321.24
K 5	1617	215.8	290.4	45.96	18.21	09.21	2196.58
K 6	1527	198.82	234.63	42.77	22.41	10.64	2036.27
K 7	1595	208.61	284.65	44.08	22.23	10.12	2164.69
K 8	1605	239.06	260.22	42.58	21.38	10.29	2178.53
K 9	1549	226.92	243.64	43.86	17.89	09.74	2091.05
P10	1700	243.12	273.10	50.29	23.61	08.82	2298.94
P11	1659	267.51	269.63	37.90	21.60	11.68	2267.32
P12	1718	224.21	320.73	39.56	22.76	11.86	2337.12
P13	1728	238.50	296.12	34.71	28.98	09.82	2336.13
P14	1720	253.23	298.11	43.83	25.26	12.04	2352.47
P15.	1525	221.81	281.32	37.28	21.09	08.40	2094.9
P16	1528	195.14	268.22	40.23	23.14	09.25	2063.98
P17	1510	212.22	284.81	40.25	20.99	07.51	2075.78
P18	1445	192.82	227.06	51.44	25.45	10.22	1951.99
P19	1554	200.71	265.42	48.78	26.2	09.35	2104.46
P20	1724	262.60	304.04	31.24	19.55	09.07	2350.5
P21	1786	261.80	347.31	45.26	22.18	11.2	2473.75
P22	1537	240.00	255.75	40.56	20.85	10.56	2104.72
P23	1662	260.04	195.91	41.56	25.50	08.84	2193.85

Table 10: Continue

P24	1724	248.56	309.00	39.62	21.08	11.49	2353.75
P25	1473	210.25	268.56	34.94	20.64	08.75	2016.14
P26	1408	195.80	255.52	40.05	19.09	07.07	1925.53
P27	1471	236.40	240.97	33.73	22.18	10.63	2014.91
P28	1543	216.80	226.11	43.15	20.67	08.49	2058.22
P29	1436	194.80	277.63	42.95	22.21	09.45	1983.04
P30	1582	228.95	246.18	41.71	18.78	09.36	2126.98
P31	1543	219.90	234.81	41.87	24.60	09.61	2073.79
P32	1668	253.86	286.9	42.43	21.63	10.59	2283.41
P33	1690	254.10	284.61	34.12	26.91	14.21	2303.95
P34	1608	241.44	269.89	45.91	20.36	10.00	2195.6
P35	1448	206.46	258.26	38.43	18.53	08.22	1977.9
P36	1396	198.40	231.96	36.11	19.72	08.26	1890.45
P37	1487	209.58	249.03	35.43	19.02	08.05	2008.11
P38	1521	223.85	280.52	40.64	22.52	08.26	2096.79
P39	1559	208.99	311.19	40.35	22.38	09.84	2151.75
P40	1595	222.09	266.72	29.50	22.27	09.11	2144.69
P41	1640	221.81	302.20	39.40	26.14	10.72	2240.27
P42	1655	236.94	312.56	45.47	25.33	12.45	2287.75
P43	1613	242.88	263.48	38.00	23.96	8.06	2189.38
P44	1690	229.88	316.13	39.76	23.64	9.32	2308.73
P45	1500	202.04	261.24	37.05	16.47	8.35	2025.15
P46	1540	210.63	286.70	37.89	19.87	09.29	2104.38
P47	1522	210.23	294.51	34.63	23.31	09.20	2093.88
P48	1445	193.68	266.99	38.68	19.85	07.40	1971.6
P49	1502	216.99	255.56	42.55	19.22	07.95	2044.27
P50	1212	184.03	180.00	32.67	20.48	06.50	1635.68
P51	1400	185.02	231.46	42.73	22.52	11.81	1893.54
P52	1575	217.25	279.81	38.02	16.37	10.72	2137.17
P53	1444	213.24	244.07	40.24	23.83	10.83	1976.21
P54	1465	226.80	235.38	42.82	25.68	09.00	2004.68
P55	1453	197.01	260.20	42.74	23.52	09.27	1985.74
P56	1430	210.60	263.98	35.82	19.07	08.61	1968.08
P57	1451	224.89	238.85	35.75	22.28	07.68	1980.45
P58	1555	221.62	281.99	37.59	21.85	08.49	2126.54
P59	1370	216.18	227.61	38.78	22.90	09.12	1884.59

Table 11: Efficiency measures on basis of weights of carcas, thighs, breast, liver, gastric and heart

	Technical efficiency		Allocative efficiency				
	Input oriented		Cost efficiency		Revenue efficiency		
DMUs	Variable (VRS-FDH)	Scale (CRS and VRS)	Variable (VRS-FDH)	Scale (CRS and VRS)	Variable (VRS-FDH)	Scale (CRS and VRS)	Average efficiency scores
K 0	1	1	1	1	0.904	0.991	0.9825
K 1	1	0.964	1	0.963	0.884	0.991	0.967
K 2	1	0.979	1	0.98	0.922	0.991	0.978667
K 3	0.946	0.946	0.96	0.938	0.811	0.991	0.932
K 4	1	0.991	1	0.993	0.937	0.991	0.985333
K 5	1	1	1	1	0.933	0.991	0.987333
K 6	1	0.954	0.994	0.953	0.87	0.991	0.960333
K 7	1	0.989	1	0.992	0.932	0.991	0.984
K 8	0.946	0.947	0.96	0.949	0.871	0.991	0.944
K 9	0.949	0.944	0.972	0.94	0.835	0.991	0.9385
P10	1	0.93	1	0.927	0.878	0.964	0.949833
P11	1	0.907	1	0.907	0.887	0.964	0.944167
P12	1	1	1	1	0.973	0.964	0.9895
P13	1	1	1	1	0.961	0.964	0.9875
P14	1	1	1	0.992	0.998	0.964	0.992333
P15	1	1	1	1	0.992	0.964	0.992667
P16	1	1	1	1	0.825	0.964	0.964833
P17	1	1	1	1	1	0.964	0.994

Table 11: Continue

P18	1	1	1	1	0.893	0.964	0.976167
P19	1	0.894	1	0.894	0.894	0.964	0.941
P20	1	0.861	0.987	0.861	0.812	1	0.920167
P21	0.971	0.858	0.966	0.857	0.775	1	0.9045
P22	1	1	1	0.996	0.945	1	0.990167
P23	1	0.927	0.987	0.929	0.806	1	0.9415
P24	1	1	1	1	1	1	1
P25	1	0.937	0.987	0.941	0.843	1	0.951333
P26	1	0.912	0.987	0.911	0.819	1	0.938167
P27	1	1	1	1	0.864	1	0.977333
P28	1	0.935	0.987	0.933	0.801	1	0.942667
P29	1	0.982	1	0.988	0.947	1	0.986167
P30	0.995	0.847	0.982	0.848	0.795	0.997	0.910667
P31	0.966	0.828	0.961	0.826	0.757	0.997	0.889167
P32	0.995	0.917	0.982	0.919	0.849	0.997	0.943167
P33	1	0.963	0.982	0.959	0.826	0.997	0.9545
P34	0.966	0.86	0.961	0.863	0.805	0.997	0.908667
P35	1	0.933	0.982	0.931	0.845	0.997	0.948
P36	0.995	0.975	0.994	0.98	0.916	0.997	0.976167
P37	1	0.951	1	0.951	0.871	0.997	0.961667
P38	1	1	1	1	0.923	0.997	0.986667
P39	1	0.977	1	0.978	0.88	0.997	0.972
P40	0.939	0.865	0.945	0.869	0.813	0.986	0.902833
P41	0.965	0.925	0.966	0.927	0.859	0.986	0.938
P42	0.965	0.889	0.966	0.892	0.848	0.986	0.924333
P43	1	0.991	1	0.991	0.902	0.986	0.978333
P44	1	1	1	1	0.923	0.986	0.984833
P45	0.965	0.931	0.966	0.931	0.846	0.986	0.9375
P46	0.965	0.865	0.966	0.865	0.794	0.986	0.906833
P47	0.965	0.962	0.966	0.964	0.876	0.986	0.953167
P48	0.965	0.895	0.966	0.893	0.82	0.986	0.920833
P49	1	0.969	1	0.969	0.931	0.986	0.975833
P50	1	0.838	1	0.838	0.923	0.892	0.915167
P51	1	0.904	1	0.903	0.923	0.892	0.937
P52	1	0.792	1	0.789	0.758	0.892	0.871833
P53	1	1	1	0.979	0.882	0.892	0.958833
P54	1	0.912	1	0.912	0.996	0.892	0.952
P55	1	0.923	1	0.927	1	0.892	0.957
P56	1	0.947	1	0.944	0.922	0.892	0.950833
P57	1	1	1	0.998	0.933	0.892	0.9705
P58	1	0.911	1	0.907	0.879	0.892	0.9315
P59	1	0.942	1	0.938	0.929	0.892	0.950167

Table 12: Prices of Inputs and Outputs (cents/gm)

Live body weight	Price outputs						Price inputs	
	Carcas	Thighs	Breast	Liver	Gastric	Heart	Starter feed	Grower feed
0.0912	0.185	0.208	0.293	0.206	0.18	0.169	0.06	0.055

Therefore, group K got the second best position. Our results show that; the group-P1 which was fed with bee pollen (5 g kg^{-1}) got the maximum mean value of average efficiency scores; group-K which was fed without bee pollen is the second best one; group-P2 which was fed with bee pollen (15 g kg^{-1}) got the third best position; group-P3 which was fed with bee pollen (25 g kg^{-1}) got the fourth best position; group-P4 which was fed with (35 g kg^{-1}) got the fifth position and group-P5 which was fed with (45 g kg^{-1}) got the last position. It means that as we increase the amount of bee pollen ore than 5 g kg^{-1} of feed mixture the efficiency of its use decreases, hence, bee pollen can be used only by 5 g kg^{-1} of feed mixture. The results obtained from this experiment are similar to that of experiment conducted by Angelovičová *et al.* (2010); the authors found that the weight of trial group of broiler which were fed with bee pollen (0.10% of feed mixture) was $P \leq 0.05$ higher than the control group of broiler. Additionally, as it is discussed in the introduction that the use of bee pollen in the poultry feed creates the immunity in chicken against the diseases, therefore, the use of bee pollen is recommended but the limit of bee pollen should be confined to 5 g kg^{-1} of feed mixture so that the profit of the firms should not decrease.

Conclusion: It was concluded that the small amount of bee pollen (5 g kg^{-1} of feed mixture) has positive effect on the economic parts of chicken meat (carcass, thighs, breast, liver, gastric and heart) in such a way that it increases the weight of those parts which have more economic value and it ensures more profit earned by the chicken producers. Any addition more than 5 g kg^{-1} has negative impact as it decreases the weights the economic parts of chicken meat (carcass, thighs, breast, liver, gastric and heart) in such a way that it decreases the profit earning by the chicken producer.

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