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EFFECT OF REPLACEMENT OF BARLEY GRAINS AND SOYBEAN MEAL BY DISTILLER'S DRIED GRAINS WITH SOLUBLES WITH OR WITHOUT SUPPLEMENTED SEAWEED IN GROWING RABBIT RATIONS ON: 1. Growth performance, feed utilization and economic efficiency of growing rabbits.

M. M. El-Shinnawy *; Eman H. M. Maklad *; Ead, H. M. E. ** Tork M. I. Dorra *** and A. M. A. Sadek*

** Department of Animal Production, Faculty of Agriculture, Mansoura University, Egypt.*

*** Animal Production Research Institute, Agricultural Research Center, Dokki, Giza, Egypt.*

****Department of Poultry Production, Faculty of Agriculture, Mansoura University, Egypt.*

Eighty one, 7 weeks of age weaning New Zealand White (NZW) rabbits were used in this study. Rabbits were randomly distributed into 9 equal groups and housed in separate cages. The 1st experimental ration (R1) was used as a control, which contained of : 10 % yellow corn + 10 % barley + 13.7 % soybean meal (SBM) + 20 % wheat bran + 40 % clover hay + 3 % molasses + 1 % calcium diphosphate + 1.2 % limestone + 0.5 % sodium chloride + 0.4 % minerals-vitamins mixture + 0.2 % methionine . Equal parts from barley and soybean meal in R1 were substituted by 10 % or 20% distiller dried grains with soluble (DDGS) in ration 2 (R2) and ration 3 (R3), respectively. The supplemented seaweed (SW) for these rations was at tow levels subtracted from the wheat bran. The first level was 0.5 % SW of the total mixed ration for ration 4 (R4), ration 5 (R5) and ration 6 (R6). The second level was 1.0 % SW of the total mixed ration for ration 7 (R7), ration 8 (R8) and ration 9 (R9).

The experimental rations had no significant effect on LBW of growing rabbits from 7 to 13 weeks of age. Rabbits fed on R1 and R3 showed the highest LBW from 7 to 13 weeks of age compared with those fed the other rations. Also, rabbits fed on R6, R8 and R9 had higher LBW than those fed on R4, R5 and R7. Averages daily gain for rabbits fed 0 % SW was higher ($P < 0.05$) than that for rabbits fed 0.5 % SW. The average changes in LBW of growing rabbits from 7 – 13 weeks of age were highest with feeding on R1 and R3 compared with that of feeding on other rations. The averages of LBW changes were nearly similar for rabbits fed on R2, R5, R6, R7, R8 and R9 and the lowest value was observed with feeding rabbits on R4 . The dressing percentages were 63.42, 62.13 and 64.01 %

and the slaughter weights were 1902.22, 1990.56 and 1948.33 g with supplemented 0.0 % , 0.5 % and 1.0 % SW respectively , while the slaughter weights were 1905.56, 19995.0 and 1940.56 g with feeding on 0.0 %, 10 % and 20 % DDGS rations, respectively. The hot carcass as were the highest (1118.33 g) with supplemented 1.0 % SW rations and (1127.22 g) with feeding on 10 % DDGS rations. Experimental rations had no significant effect on averages of DMI of growing rabbits from 7 to 13 weeks of age. No significant effect was detected due to feeding experimental rations on feed conversion values of growing rabbits from 7 – 13 weeks of age.

The economic efficiency (%) results showed that feeding growing rabbits on R3 recorded the highest value (313.3 %), while feeding on R4, R5, R7 and R8 showed the lowest values being 259.2, 251.5, 244.3 and 255.2 %, respectively.

Keywords: Performance, DDGS, SW, feed utilization, economic efficiency.

The importance of nutrition has increased significantly as feed cost, pathological conditions associated with energy and nutrient deficiencies and considerations of product quality have become limiting factors to economic output from a unit. The rabbit is unique. It requires a high daily nutrient and energy intake but, because it is an herbivore, it also needs a diet with a high concentration of fiber to ensure optimum performance and, in addition, to minimize the incidence of digestive disorders (Padilha *et al*., 1999).

High starch diets are often incompletely digested in the rabbit small intestine due to rapid transit time (McNitt *et al*., 1996). Incomplete digestion of starch prior to the large intestine results in the availability of starch for microbial fermentation (Steves and Hume, 1995). Excess starch in the gut results in an extremely rapid fermentation with possible spilling of energy leading to low Yatp. For example, Oba and Allan (2003) showed that, as the rate of starch digestion increased, the Yatp was reduced from 60g of microbial N/kg starch digested to approximately 30 g microbial N/kg starch digested. The rapid digestion of starch could lead to a much lower microbial cell yield in starch fermentation in the caecum of concentrate-fed as compared to forage-fed rabbits.

Distiller's dried grains with solubles (DDGS) are a valuable feed ingredient which is a co-product of dry mill ethanol production from grains. In ethanol production, the starch is fermented to obtain ethyl alcohol and the remaining components of the grain kernel (endosperm, germ) preserve much of the original nutrients of the grain including energy, protein and phosphorus (Bremer *et al*., 2005). Distiller's dried grains with solubles (DDGS) is quite variable in nutritional content and quality among different sources (Widyaratne and Zijlstra, 2007). Many growing – finishing swine diets contain 10 % DDGS and have resulted in pig performance equal to that achieved when feeding a typical corn-SBM diet with some diet cost saving. At higher levels of DDGS inclusion, average daily gain (ADG) and average daily feed intake (ADFI) responses have been inconsistent. If growing-finishing swine diets can include 20 % DDGS and achieve the same pig performance as corn – SBM diets, the cost savings to pork producer can be even greater than that achieved when using it at the 10 % DDGS inclusion level. Although the DDGS contains a significant amount of crude fiber (8 – 10 %), it also contains 10 – 12 % fat (Whitney *et al.*, 1999). Fats as energy carriers and sources of essential unsaturated fatty acids have attracted the attention of nutritionists in recent years.

Aga *et al*. (2000) were used a calcified seaweed (SW) as a buffer in continuous culture of rumen contents. The chemical composition of an ordinary SW as from *Ascophyllum nodosum*, immediately characterizes the material as of low energy content, according to the analytical data the value of seaweed meal must primarily be sought in its contents of vitamins and minerals, among which β-carotene, tocopherols, some B vitamins, iodine, zinc and potassium are the more important (Scott, 1990). The rational way of using SW meal in rations would be to let this component to supply the above active substances according to the analytical data and to add the factors to obtain a balanced diet. Sykes, (2009) reported that SW is totally natural multi-mineral supplement. Seaweed contains all minerals and trace elements an animal requires for a normal healthy life.

The objective of this study was to evaluate the effect of partially or totally substituting of barley and partially soybean meal by DDGS with or without SW supplementation on growth performance, feed utilization and economic efficiency of New Zealand White (NZW) growing rabbits.

MATERIALS AND METHODS

The experimental field of the present study was carried out at the Experimental Station of the Poultry Production Department, while, the chemical analyses were run at the Laboratory of the Animal Production Department, Faculty of Agriculture, Mansoura University, Mansoura, Egypt.

Experimental animals, housing and management.

Eighty one, 7 weeks old weaning NZW rabbits were used in this study. Rabbits were randomly distributed into 9 equal groups and housed in separate cages with the following dimensions (50 ×50×45cm) for length, width and height, respectively. Rabbits were fed the experimental diets for 91 days (13 week of age). Feed and water were offered *ad libitum* throughout the experimental period. The values of live body weight, daily gain, feed intake, feed conversion ratio and economical efficiency were recorded.

Experimental rations and design.

The experimental groups were fed randomly on one of nine formulated pelleted experimental rations. Rations were formulated to meet the nutrient requirements of growing rabbits according to NRC (1977) recommendations as shown in Table 1.

Table 1. Ingredients and chemical composition of the experimental diets.

Items	**Experimental diets**								
	R1	**R2**	**R3**	**R4**	**R5**	**R6**	**R7**	**R8**	**R9**
Distiller dried grains with soluble (DDGS, %)	**0 .0**	**10 .0**	**20 .0**	**0 .0**	**10 .0**	**20 .0**	**0 .0**	**10 .0**	**20 .0**
Seaweed (SW, %):		**0.0**			**0.5**			**1.0**	
Yellow corn	10	10	10	10	10	10	10	10	10
Barley	10	5	0	10	5	0	10	5	0
Soybean	13.	8.7	3.7	13.	8.7	3.7	13.	8.7	3.7
DDGS*	0	10	20	0	10	20	0	10	20
Wheat bran	20	20	20	19.	19.	19.	19	19	19
Clover hay	40	40	40	40	40	40	40	40	40
Seaweed (SW)	0	0	0	0.5	0.5	0.5	1	1	1
Molasses	3	3	3	3	3	3	3	3	3
Calcium di phosphate	1	1	1	1	1	1	1	1	1
Limestone	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Sodium chloride	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5	0.5
Premix	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4	0.4
Methionine	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2	0.2
Total	**10**	**10**	**10**	**10**	**10**	**10**	**10**	**10**	**10**
Calculated chemical constituents for CP and CF (% DM) **(Kearl *et al.*, 1979):**									
Crude protein	1	1	1	1	17.3	16.8	17.8	17.3	1
Crude fiber	1	1	1	1	15.2	15.3	15.0	15.2	1

Premix: A vitamin - mineral mixture was obtained from Misr Feed Additive Co.. Contents each 1.5 kg of the Premix were Vit A, 12000000 IU; Vit D_3, 2200000 IU; Vit E, 10 gm; Vit K_3, 2000 mg; Vit B_1, 1000 mg; Vit B_2, 5000 mg; Vit B_6, 1500 mg; Vit B_{12}, 10 mg; Nicotnic, 30000 mg; Pantothenic, 10000 mg; Folic acid, 1000 mg; Biotin, 50 mg; Ca Co_3: add to 1.5 kg; Manganese, 60 gm; Zin, 50 gm; Iron, 30 gm; Copper, 4 g; Iodin, 1 gm; Selenium, 0.10 gm; and Cobalt, 0.10 gm. The inclusion rate was 4 Kg / ton of feed to cover the requirements of growing rabbits according to NRC (1977) recommendations.

Growth performance parameters:

Live body weight of the experimental rabbits was individually recorded at weekly intervals. Average body weight gain (g / rabbit), average live body weight change (%),feed intake and feed conversion ratio(g feed/g gain) were determined weekly.

Carcass evaluation:

At the end of the experimental period, three rabbits from each experimental treatment were chosen at random and slaughtered to study carcass characteristics. Rabbits were fasted for approximately 18 hours before slaughtering, individually weighed and slaughtered by severing the neck with a sharp knife according to Islamic religion. Slaughter data were recorded thereafter. Skinning was carried out by removing the skin including tail and legs. The different organs (liver, heart, kidneys, viscera and lungs) were removed and every organ was immediately weighed to the nearest gram and recorded. The rest of body (carcass) for each rabbit was weighed.

Economical efficiency:

The local price of daily body weight gain and daily feed cost were calculated depending on the prevailing prices being:

- Price of kg body weight = 20.00 LE, Price (pt) / kg (as fed) ingredients was: clover hay = 140; DDGS = 215; seaweed = 700; wheat bran = 160; yellow corn = 191; barley = 200; soybean meal = 312; sugar cane molasses = 50; limestone = 46; sodium chloride = 50; calcium diphosphate = 600; minerals and vitamins mixture = 750; Methionine = 3200.
- Total feed cost = Average feed intake (kg) × price per (kg) feed.
- Weight gain price = Average weight gain (kg) × Price per kg live body weight.
- Profit (LE) = Price of weight gain – Price of feed cost.
- Economic efficiency (%) = Profit (LE) × 100 / Total feed cost.

Statistical analysis:

Statistical analysis of data obtained was carried out using the General Linear Model Program (GLM) of SAS (2000). The obtained data for productive traits of different groups of rabbits were subjected to factorial analysis of variance according to the following model:

$$Y_{ijk} = \mu + T_i + L_j + TL_{ij} + e_{ijk}$$

Where; Y i j k = Observation of the tested factor, µ = Overall mean, Ti = The effect of treatment levels (DDGS), i = 0, 10 and 20 %, L j = The effect of levels (Seaweed), j = 0, 0.5 and 1 %, TLij = The interaction between treatment DDGS and Seaweed levels and eijk = Random error.

Differences among means were subjected to Duncan's Multiple Range Test (Duncan, 1955).

RESULTS AND DISCUSSION

Data in Table (2) showed that the experimental rations had no significant effect on LBW of growing rabbits from 7 to 13 weeks of age.

As shown in Table 2, LBW was higher (P < 0.05) from 10 up to13 weeks for rabbits fed the control ration than for those fed the ration supplemented with 0.5 % SW. The average LBW from 7 to 13 weeks of age was 1.491, 1.367 and 1.399 kg for rabbits fed rations with supplement 0.0, 0.5

Table 2. Effect of SW supplementation and feeding DDGS and their interaction on live body weight (Kg) of growing rabbits from 7 to 13 weeks of age.

Items	Live body weight (Kg) at							
	7 Wk	8 Wk	9 Wk	10 Wk	11 Wk	12 Wk	13 Wk	7-13 Wk
Seaweed (SW):								
0.0	0.820	1.126	1.414	1.723 [a]	1.915 [a]	2.101 [a]	2.311 [a]	1.491 [a]
0.5	0.807	1.084	1.338	1.587 [b]	1.770 [b]	1.967 [b]	2.174 [b]	1.368 [b]
1.0	0.811	1.080	1.329	1.572 [b]	1.794 [b]	2.010 [ab]	2.210 [ab]	1.399 [ab]
± SEM	0.005	0.018	0.030	0.039	0.038	0.036	0.034	0.034
P	**0.156**	**0.153**	**0.109**	**0.026**	**0.033**	**0.047**	**0.029**	**0.048**
Distiller dried grains with soluble (DDGS, %)								
0	0.812	1.104	1.374	1.646	1.834	2.018	2.208	1.395
10	0.820	1.083	1.338	1.607	1.813	2.012	2.216	1.396
20	0.806	1.102	1.369	1.630	1.831	2.048	2.272	1.466
± SEM	0.005	0.018	0.030	0.039	0.038	0.036	0.034	0.034
P	**0.172**	**0.661**	**0.662**	**0.783**	**0.918**	**0.750**	**0.375**	**0.265**
Interaction between SW x DDGS								
R1	0.819	1.151	1.442	1.768	1.943	2.134	2.316	1.496
R2	0.839	1.107	1.373	1.667	1.852	2.035	2.258	1.419
R3	0.804	1.120	1.428	1.735	1.950	2.133	2.361	1.557
R4	0.810	1.085	1.345	1.591	1.767	1.940	2.146	1.336
R5	0.804	1.091	1.338	1.598	1.800	1.968	2.157	1.354
R6	0.806	1.077	1.330	1.573	1.743	1.994	2.220	1.414
R7	0.808	1.077	1.334	1.579	1.792	1.980	2.162	1.354
R8	0.817	1.052	1.303	1.555	1.788	2.032	2.233	1.416
R9	0.809	1.110	1.348	1.583	1.800	2.016	2.235	1.427
± SEM	0.009	0.030	0.051	0.068	0.066	0.062	0.059	0.058
P	***0.272***	**0.708**	**0.959**	**0.933**	**0.811**	**0.757**	**0.852**	**0.770**

a, b, c : Means within the same raw with different superscripts are significantly different (P <0.05).
SEM = Standard error of means., P = Probability. Wk: Week

and 1.0 % SW, respectively. However, there were no significant differences in LBW for rabbits fed on 0.0, 10 and 20 % DDGS, but LBW of rabbits tended to increase with feeding on 20 % DDGS (1.466 kg) than feeding on 0.0 or 10 % DDGS (1.395 and 1.396 kg, respectively).

Rabbits fed on R1 and R3 showed the highest LBW from 7 to 13 weeks of age (1.496 and 1.557 kg, respectively) compared with those fed the other rations. Also, rabbits fed on R6, R8 and R9 had higher LBW (1.414, 1.416 and 1.427 kg, respectively) than those fed on R4, R5 and R7 (1.336, 1.354 and 1.354 kg, respectively).

Although the DDGS contains a significant amount of crude fiber (8 – 10 %), it also contains 10 – 12 % fat (Whitney *et al*., 1999). Fats as energy carriers and sources of essential unsaturated fatty acids have attracted the attention of nutritionists in recent years. The activity of these acids in the animal body is reflected mainly in the activity of eicosanoids (Known as tissue hormones). Owing to the mechanism of their action, they can be treated as the most peripheral first messengers, which strengthen or weaken the regulatory activity of hormones and neuromediators at cellular level (Corl *et al*., 2003). Because fat has high efficiency of conversion of the ME into retained energy and supplies essential fatty acids, the fat was often used in commercial meat rabbit production.

The effect of feeding growing rabbits on DDGS with or without SW had no significant effect on average daily gains from 7 – 13 weeks of age as shown in Table 3. The average daily gain for rabbits fed 0 % SW was higher ($P<0.05$) (35.49 g/h/d) than that for rabbits fed 0.5 % SW (32.56 g/h/d), but there were no significant effect due to feeding difference DDGS levels on average daily gain of rabbits from 7 – 13 weeks of age (33.23, 33.24 and 34.90 g/h/d with feeding on 0.0, 10, 20 % DDGS, respectively). However, average daily gains from 7 to 13 weeks of age were higher for rabbits fed on R1 and R3 (35.63 and 37.06 g/h/d, respectively) compared to those for rabbits fed the other rations. Also, feeding on R6, R8 and R9 showed higher average daily gains (33.66, 33.71 and 33.97 g/h/d, respectively) than those of rabbits fed on R4, R5 and R7 being 31.80, 32.22 and 32.25 g/h/d, respectively.

Schiere (2004) reported that growth rates for rabbits of around 15 – 20 grams per day are common in the tropics even though it is possible to obtain 30 – 40 grams per day on very good food. The growth rates of young rabbits are strongly correlated with adult size and weight where there has been no marked dietary deficiency.

There was no significant effect for experimental rations on the weekly change of live body weight of growing rabbits from 7– 13 weeks of age (Table 4), except with feeding on R8 and R9 at 11 – 12 weeks of age as the changes were significantly ($P<0.05$) higher than those of feeding on the other rations. The average changes in LBW of growing rabbits from 7 – 13 weeks of age were highest with feeding on R1 and R3 (19.46 and 20.14 %, respectively) compared with that of feeding on other rations. The averages of LBW changes were nearly similar for rabbits fed on R2, R5, R6, R7, R8 and R9 (about 18.4 %) and the lowest value was observed with feeding rabbits on R4 (17.96 %) as shown in Table 4 and Figure 1.

Table 3. Effect of SW supplementation and feeding DDGS and their interaction on average daily gain (g/h/d).

Items	Average daily gain (g/h/d)from :						
	7-8 Wk	8-9 Wk	9-10 Wk	10-11 Wk	11-12 Wk	12-13 Wk	7-13 Wk
Seaweed (SW):							
0.0	43.60	41.19	44.19[a]	27.34	26.55	30.09	35.49[a]
0.5	39.68	36.22	35.61[b]	26.08	28.21	29.55	32.56[b]
1.0	38.33	35.58	34.81[b]	31.63	30.85	28.64	33.31[ab]
± SEM	2.402	2.251	2.110	1.677	1.337	1.164	0.801
P	**0.298**	**0.184**	**0.010**	**0.075**	**0.099**	**0.679**	**0.048**
Distiller dried grains with soluble (DDGS, %)							
0	41.69	38.52	38.86	26.90	26.27	27.12[b]	33.23
10	37.65	36.38	38.40	29.48	28.35	29.17[ab]	33.24
20	42.28	38.10	37.35	28.66	30.99	32.00[a]	34.90
± SEM	2.402	2.251	2.110	1.677	1.337	1.164	0.801
P	**0.354**	**0.779**	**0.876**	**0.551**	**0.068**	**0.027**	**0.264**
Interaction between SW X DDGS							
R1	47.38	41.62	46.53	25.00	27.34	25.91	35.63
R2	38.33	37.90	42.14	26.35	26.11	31.87	33.78
R3	45.08	44.05	43.89	30.67	26.19	32.50	37.06
R4	39.29	37.18	35.08	25.16	24.64	29.44	31.80
R5	41.11	35.32	37.06	28.81	24.05	26.98	32.22
R6	38.65	36.15	34.68	24.29	35.95	32.22	33.66
R7	38.41	36.75	34.96	30.56	26.83	25.99	32.25
R8	33.49	35.91	35.99	33.29	34.90	28.67	33.71
R9	43.10	34.09	33.49	31.03	30.83	31.27	33.97
± SEM	4.161	3.899	3.654	2.905	2.315	2.015	1.388
P	**0.540**	**0.888**	**0.914**	**0.615**	**0.014**	**0.382**	**0.769**

a, b, c : Means within the same raw with different superscripts are significantly different ($P < 0.05$).
SEM = Standard error of means., P = Probability. Wk: Week

Table 4. Interaction between feeding on DDGS and with or without seaweed SW on Change (%) of weekly live body weight of growing rabbits from 7 – 13 weeks of age.

Items	R1	R2	R3	R4	R5	R6	R7	R8	R9	± SEM	*P*
DDGS(%)	**0 .0**	**10 .0**	**20 .0**	**0 .0**	**10 .0**	**20 .0**	**0 .0**	**10 .0**	**20 .0**		
SW(%)		**0.0**			**0.5**			**1.0**			
Wk (7 – 8)	40.53	31.95	39.27	33.96	35.80	33.56	33.28	28.75	37.34	3.592	0.477
Wk (8 – 9)	25.24	23.91	27.55	23.94	22.55	23.50	23.86	23.91	21.42	2.131	0.681
Wk (9–10)	22.70	21.40	21.55	18.22	19.47	18.10	18.25	19.33	17.39	1.680	0.932
Wk (10–11)	9.89	11.11	12.38	11.18	12.73	10.97	13.62	15.04	13.80	1.493	0.835
Wk (11–12)	9.90	10.08	9.40	9.73	9.39	14.59	10.49	13.69	12.03	1.161	0.044
Wk (12–13)	8.50	11.08	10.68	10.70	9.63	11.34	9.24	9.87	10.84	0.848	0.351
Average WK (7-13)	19.46	18.25	20.14	17.96	18.26	18.68	18.12	18.43	18.80	0.615	0.627

SEM = Standard error of means. *P* = Probability. Wk: Week

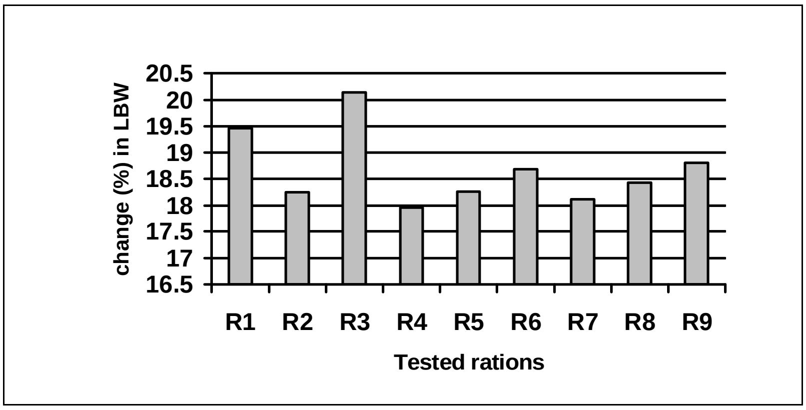

Figure 1. The effect of feeding DDGS with or without SW on change (%) in LBW.

Feed composition such as a dietary fiber, interacts with the digestive health of the young animal (Montagne *et al.*, 2003) and particularly of the growing rabbit after weaning (Gidenne, 2003). The nutritional needs of the growing rabbit after weaning were more demonstrated that the fiber intake greatly favors the resistance to the digestive troubles (Bennegadi *et al.*, 2001), while the starch intake has a weak effect (Gidenne *et al.*, 2005).

Because fat has high efficiency of conversion of the ME into retained energy and supplies essential fatty acids, the fat was often used in commercial meat rabbit production. NRC (1977) recommended that the dietary fat requirement of growing rabbits was 2 – 5 %, the addition of fat to diets of growing rabbits increased digestible energy content and feed conversion ratio (Santoma *et al.*, 1987) when diets contain high fiber content.

Supplements of seaweed may improve the nutritive quality of diet and growth of small animal and birds in terms of body weight gain, fats and protein contents (Zahid Phool *et al.*, 1995).

Data in Table (5) showed that there was no significant effect due to supplemented SW or feeding DDGS on all carcass characteristics of growing rabbits at 13 weeks of age except for skin weight which was higher ($P < 0.05$) (386.11 g) with supplemented 0.5 % SW ration than with 0.0 % (354.44 g) or supplemented 1.0 % SW (355.0 g) ones and lungs weight, which was higher ($P < 0.05$) for rabbits fed on R3 or R8 (23.33 g for each) than that of rabbits fed on the other rations.

The dressing percentages were 63.42, 62.13 and 64.01 % and the slaughter weights were 1902.22, 1990.56 and 1948.33 g with supplemented 0.0 % , 0.5 % and 1.0 % SW respectively , while the slaughter weights were 1905.56, 19995.0 and 1940.56 g with feeding on 0.0 %, 10 % and 20 % DDGS rations, respectively. The hot carcass as were the highest (1118.33 g) with

supplemented 1.0 % SW rations and (1127.22 g) with feeding on 10 % DDGS rations as shown in Table 5.

The dressing percentage (with edible parts) was the highest (65.54 %) for rabbits fed on R8 as shown in Figure 2. The slaughter weight was the highest for rabbits fed on R5 and R 8 (2065.0 and 2023.33 g, respectively) compared with that fed on the other rations. The hot carcass was also, the highest (1131.67 and 1190.0 g, respectively) for rabbits fed the same rations, but the dressing percentages (without edible parts) were the highest for rabbits fed on R7 and R8 (55.55 and 56.2 %) compared with those of rabbits fed on the other rations as shown in Figure 3.

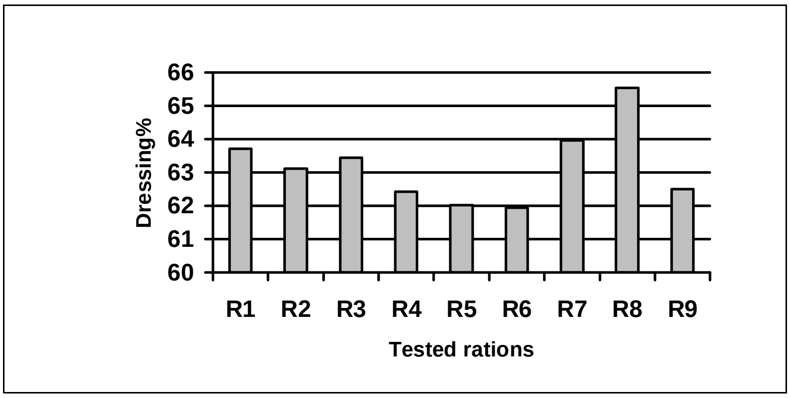

Figure 2. The effect of feeding DDGS with or without SW on dressing percentage (with edible parts).

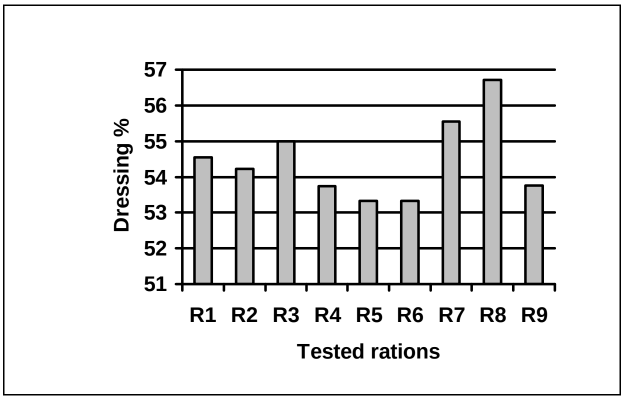

Figure 3. The effect of feeding DDGS with or without SW on dressing percentage (without edible parts).

The most frequently reported benefits associated with inclusion SW of *Ascophllum nodosum* in animal diet include increased weight gain and improved carcass quality (Scott, 1990). Slaughter yield improves with age, for a given carcass weight, animals at high growth rate, receiving more balanced feed, generally have a better carcass yield (Lebas and Colin, 1992). Too much roughage in the diet tends to develop the digestive tract and thereby lower carcass yield.

Experimental rations had no significant effect on averages of DMI of growing rabbits from 7 to 13 weeks of age, as presented in Table 6. Averages of DMI were the highest with feeding on R3, R6 and R8 (92.16, 92.09 and 92.42 g/h/d, respectively) compared with those of rabbits fed the other rations. Also, averages of DMI of rabbits fed on R1 and R5 (90.26 and 90.65 g/h/d, respectively) were higher than those of rabbits fed on R2, R4, R7 and R9 (88.02, 85.60, 89.63 and 89.64 g/h/d, respectively).

Table 6. Effect of SW supplementation and feeding DDGS and their interaction on average dry matter intake (g/h/d) of growing rabbits from 7 to 13 weeks of age.

Items	Average dry matter intake (g/h/d) at:						
	7-8 Wk	8-9 Wk	9-10 Wk	10-11 Wk	11-12 Wk	12-13 Wk	7-13 Wk
Seaweed (SW):							
0.0	59.07	68.09	75.42	102.22	114.55	121.53	90.15
0.5	58.54	66.89	75.74	98.89	112.22	124.40	89.45
1.0	60.97	68.46	76.26	102.45	113.90	121.35	90.57
± SEM	0.885	0.810	0.769	1.590	3.398	2.299	0.873
P	**0.153**	**0.375**	**0.738**	**0.236**	**0.883**	**0.583**	**0.664**
Distiller dried grains with soluble (DDGS, %)							
0	58.61	67.53	75.62	100.69	106.38 [b]	122.16	88.50
10	59.88	67.80	75.99	102.05	113.34 [ab]	123.13	90.36
20	60.10	68.11	75.81	100.82	120.96 [a]	121.99	91.30
± SEM	0.885	0.810	0.769	1.590	3.398	2.299	0.873
P	**0.457**	**0.881**	**0.942**	**0.804**	**0.024**	**0.932**	**0.097**
Interaction between SW X DDGS							
R1	58.78	67.16	76.12	105.00	108.86	125.64	90.26
R2	60.13	69.09	74.63	102.77	108.60	112.90	88.02
R3	58.30	68.03	75.49	98.90	126.19	126.04	92.16
R4	56.69	65.74	74.58	94.53	100.08	121.99	85.60
R5	59.44	66.60	76.47	100.74	113.75	126.91	90.65
R6	59.51	68.32	76.17	101.41	122.84	124.31	92.09
R7	60.38	69.69	76.15	102.56	110.19	118.84	89.63
R8	60.07	67.72	76.88	102.63	117.66	129.57	92.42
R9	62.48	67.98	75.76	102.15	113.87	115.63	89.64
± SEM	1.533	1.403	1.333	2.754	5.885	3.983	1.511
P	**0.603**	**0.482**	**0.731**	**0.252**	**0.323**	**0.025**	**0.063**

a, b, c : Means within the same raw with different superscripts are significantly different (P <0.05).
SEM = Standard error of means., P = Probability. Wk: Week

The inclusion of seaweed in animal diets increased feed consumption and improved digestive system (Scott, 1990). During the weaning to slaughter growth period the rabbit should always be fed *ad libitum*. If the breeder was balanced diets, the average daily consumption will be 100 to 130 g for medium size rabbits. In good conditions the rabbits will gain 30 to 40 g / day, which means on intake of 3.0 to 3.5 kg feed will produce a 1 kg gain in live weight (Labes and Colin, 1992).

The beneficial role of fiber in preventing digestive disease is mostly based on the control of intestinal microbiota through its effects on the digestive transit, and its availability as substrate for bacterial growth. Using common sources of fiber in weaning rabbits diet, Gutierrez *et al*. (2002), and Feugier *et al*. (2006), showed that 30 – 32 % neutral detergent fiber (NDF) reduced mortality and enhanced performance and feed efficiency, in associated with an improvement of mucosal structure (Alvarez *et al*., 2007).

Increasing the energy content of the diet also results in increasing metabolic rate, more oxygen consumption and decreasing the feed conversion rates (Khazali and Moravej, 2003).

No significant effect was detected due to feeding experimental rations on feed conversion values of growing rabbits from 7 – 13 weeks of age as shown in Table 7. The average feed conversion values from 7 to 13 weeks of age were poorest (highest) for rabbits fed on R5, R6, R7 and R8 being 2.82, 2.74, 2.79 and 2.74 g DMI / g daily gain, respectively, while the best (lowest) values were recorded with rabbits fed on R1 and R3 (2.54 and 2.49 g DMI / g daily gain, respectively).

Data are presented in Table 8 showed that the economic efficiency (%)for rabbits fed 0 % SW was the highest value (295.73 than that for rabbits fed 0.5 % SW (254.07) and fed 1.0 % SW (259.5).Moreover, the economic efficiency (%)for rabbits fed 20 % DDGS was the highest value (287.77)than that for rabbits fed 0.0 % DDGS (264.40) and fed 10 % DDG (263.63).

The economic efficiency (%) results showed that feeding growing rabbits on R3 recorded the highest value (313.3 %), as shown in Table (8), while feeding on R4, R5, R7 and R8 showed the lowest values being 259.2, 251.5, 244.3 and 255.2 %, respectively. Feeding on R1, R2, R6 and R9 had an intermediate economic efficiency value (289.7, 284.2, 271.0 and 279.0 %, respectively).

By-product feed can serve as a source of nutrients in animal diets. Often, by-product feeds such as distillers grains could be included in the diet if they are readily available and economically justified, especially when there is a shortage or increase in prices of conventional feed sources. Also, due to the processing methods employed, nutrients in the by-product become more biologically available and can potentially reduce nutrient excretion if the by-product nutrient can be balanced in the diet (Spiehs *et al*., 2002).

Table 7. Effect of SW supplementation and feeding DDGS and their interaction on feed conversion ratio (dry matter intake (g) / daily gain (g)) of growing rabbits from 7 to 13 weeks of age.

Items	Feed conversion ratio (dry matter intake (g) / daily gain (g))						
	7-8 Wk	**8-9 Wk**	**9-10 Wk**	**10-11 Wk**	**11-12 Wk**	**12-13 Wk**	**7-13 Wk**
Seaweed (SW, %):							
0.0	1.41	1.71	1.73 [b]	3.85	4.38	4.14	2.55 [b]
0.5	1.51	1.89	2.23 [a]	3.89	4.15	4.27	2.75 [a]
1.0	1.63	1.96	2.23 [a]	3.32	3.74	4.30	2.73 [a]
± SEM	0.098	0.120	0.150	0.236	0.232	0.180	0.056
P	**0.322**	**0.329**	**0.045**	**0.189**	**0.176**	**0.799**	**0.036**
Distiller dried grains with soluble (DDGS, %)							
0	1.43	1.80	2.01	3.91	4.12	4.59 [a]	2.67
10	1.67	1.90	2.01	3.54	4.15	4.29 [ab]	2.73
20	1.45	1.86	2.16	3.62	4.00	3.83 [b]	2.63
± SEM	0.098	0.120	0.150	0.236	0.232	0.180	0.056
P	**0.189**	**0.861**	**0.720**	**0.527**	**0.896**	**0.026**	**0.444**
Interaction between SW X DDGS							
R1	1.26	1.70	1.64	4.39	4.00	4.88	2.54
R2	1.68	1.88	1.81	3.91	4.27	3.63	2.62
R3	1.30	1.55	1.73	3.26	4.85	3.90	2.49
R4	1.46	1.78	2.14	3.87	4.25	4.23	2.70
R5	1.52	1.93	2.07	3.51	4.75	4.71	2.82
R6	1.54	1.96	2.47	4.31	3.46	3.86	2.74
R7	1.58	1.93	2.25	3.47	4.11	4.65	2.79
R8	1.81	1.89	2.15	3.20	3.43	4.52	2.74
R9	1.50	2.06	2.29	3.30	3.70	3.72	2.65
± SEM	0.170	0.208	0.261	0.409	0.402	0.312	0.096
P	**0.747**	**0.776**	**0.907**	**0.356**	**0.109**	**0.110**	**0.863**

a, b, c : Means within the same raw with different superscripts are significantly different (P <0.05).
SEM = Standard error of means, P = Probability. Wk: Week

Conclusively, the present study suggested the possibility of using DDGS with or without SW in rations for growing rabbits in place of barley and soybean meal till 20 % without adverse effect.

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تأثير إحلال النواتج العرضية لتقطير الحبوب المجففة بالسوائل محل حبوب الشعير وكسب فول الصويا مع إضافة أو بدون إضافة الطحالب البحرية فى علائق الأرانب النامية على

١- معدلات النمو، الاستفادة الغذائية، الكفاءة الاقتصادية للأرانب النامية.

محمد محمد الشناوي *، إيمان حنفى محمود مقلد*، حسين محمد الشافعي عيد، ترك محمد إبراهيم درة***، أحمد ماهر أمين صادق*.**

*** قسم إنتاج الحيوان - كلية الزراعة - جامعة المنصورة - المنصورة - ج.م.ع.**

**** معهد بحوث الإنتاج الحيواني - مركز البحوث الزراعية - الدقى - ج.م.ع.**

***** قسم إنتاج الدواجن - كلية الزراعة - جامعة المنصورة - المنصورة - ج.م.ع.**

تم اختيار ٨١ أرنبا نيوزيلندي أبيض عمر ٧ أسابيع بمتوسط وزن ٨١٣ جم وتم توزيعهم عشوائيا في تسع مجاميع متساوية في العدد والعمر ووزن الجسم. تم تغذية الأرانب على تسع علائق تجريبية على النحو التالي: العليقه (الأولى) المقارنة تحتوى على: ١٠ % ذرة صفراء + ١٠ % شعير + ١٣,٧ % كسب فول الصويا + ٢٠ % نخالة قمح + ٤٠ % دريس برسيم + ٣ % مولاس + ١ % داى كالسيوم فوسفات + ١,٢ % حجر جيرى + ٠,٥ % ملح طعام + ٠,٤ % مخلوط معدنى وفيتامينات + ٠,٢ % مثيونين.وتم إحلال النواتج العرضية لتقطير الحبوب المجففة بالسوائل محل الشعير وكسب فول الصويا بنسبة ١٠ ، ٢٠ % (كل من النسبة مقسمه على كل من الشعير وكسب فول الصويا بنسب متساوية) وذلك للعلائق (الثانية والثالثة). ثم تم إضافة الطحالب البحرية لهذه العلائق بنسبة ٠,٥ % وذلك لكل من العليقة الرابعة والخامسة والسادسة. كما تم إضافة الطحالب البحرية لهذه العلائق بنسبة ١ % وذلك لكل من العليقة السابعة والثامنة والتاسعة. وكانت جميع العلائق على شكل مكعبات ومتساوية في الطاقة والبروتين تقريبا. وطبقا للاحتياجات المطلوبة لتغذية الأرانب النامية.

وكانت أهم النتائج المتحصل عليها هى كما يلى:-

- لم تظهر فروق معنوية على أوزن الأرانب خلال الفترة من ٧ – ١٣ أسبوع عند التغذية على العلائق المختبرة.وتلاحظ أن التغذية على العليقة الأولى والثالثة كانت الأعلى فى الزيادة فى وزن الجسم خلال الفترة ٧ – ١٣ أسبوعاً مقارنة بالتغذية على العلائق التجريبية الأخرى كما كانت أوزان الأرانب التى تغذت على العلائق السادسة والثامنة والتاسعة أعلى من وزن الأرانب التى تغذت على العلائق الرابعة والخامسة والسابعة.
- زاد معدل النمو اليومى معنويا بدون إضافة طحالب بحرية مقارنة بالعلائق المضاف اليها ٠,٥ % طحالب بحرية) ولكن لم تظهر فروق معنوية بالتغذية

على النواتج العرضية لتقطير الحبوب المجففة بالسوائل بمستوياتها المختلفة على معدل النمو اليومي وذلك من خلال الفترة ٧ – ١٣ أسبوع.

- **زاد معدل التغير فى وزن الجسم عند التغذية على العليقة الأولى والثالثة مقارنة بالتغذية على العلائق الأخرى.**
- **زاد نسبة التصافي بإضافة الطحالب البحرية مقارنة بإضافة صفر ، ٠,٥ % طحالب وكان الوزن الصافي للذبيحة الأعلى بإضافة ١% طحالب بحرية أو عند التغذية على ١٠% من النواتج العرضية لتقطير الحبوب.**
- **لم تتأثر المادة الجافة المأكولة معنويا عند التغذية على العلائق التجريبية ولكن زاد المأكول بالتغذية على العلائق الثالثة ، السادسة ، الثامنة. كما لم تظهر فروق معنوية على معدل التحويل الغذائى عند التغذية على هذه العلائق وذلك خلال الفترة من ٧ – ١٣ أسبوع ولكن كان معدل التحويل منخفضا عند التغذية على العلائق الخامسة والسادسة والسابعة والثامنة مقارنة بالتغذية على العلائق الأولى والثالثة حيث كانت الأفضل فى معدل التحويل الغذائي.**
- **تحسنت الكفاءة الاقتصادية عند التغذية على العليقه الثالثة (٣١٣,٣ %) مقارنة بالتغذية على العلائق التجريبية الأخرى. بينما كانت متوسطة عند التغذية على العلائق الأولى ، الثانية، السادسة و التاسعة (٢٨٩,٠٧ و ٢٨٤,٠٢ و ٢٧١,٠ و ٢٧٩,٠ % ، على التوالي). بينما انخفضت عن التغذية على العلائق الرابعة، الخامسة، السابعة والثامنة (٢٥٩,٠٢ و ٢٥١,٠٥ و ٢٤٤,٠٣ و ٢٥٥,٠٢ % ، على التوالي).**

التوصية: يستنتج من هذه الدراسة أنه من الممكن تغذية الأرانب النامية بعد الفطام عمر (٧ – ١٣ أسبوعاً) على علائق تحتوى على نواتج تقطير الحبوب حتى نسبة ٢٠% ، وكانت التغذية على العليقة الثالثة الأعلى من حيث الكفاءة الاقتصادية، وذلك بالرغم ان التغذية على العليقة الثامنة كانت الأعلى من حيث تصافى الذبيحة بدون الأجزاء المأكولة الأمر، الذى يتطلب إجراء تجارب مستقبلا مع أنواع أخرى وخاصة عند التغذية على علائق مثل العليقة الثامنة للحكم على مدى الاستفادة منها، هذا بجانب العمل على خفض ثمن وحدة الطحالب البحرية المضافة لزيادة الكفاءة الاقتصادية.