4. RESULTS AND DISCUSSION

4.1. Chemical Analysis of Tested By-Product Meals.

The chemical analysis (on DM basis) of the tested by-product meals, tomato by-product meal (TBM), potato by-product meal (PBM), pea hulls meal (PHM) and date stone meal (DSM) are presented in Table (6).

Results obtained showed that the highest value of OM was recorded by DSM (98.68%) and the lowest value was shown by TBM (82.77), while the other tested by-product meals have intermediate values being 90.33 and 86.72% for PBM and PHM, respectively. The percentage of CP in PHM recorded the highest value (25.74%) followed by TBM (22.83%) and PBM (18.38%), while DSM had the lowest value (7.36%). The percentage of EE in DSM achieved the highest value (5.72%) followed by TBM (2.54%) and the lowest EE values were shown by PBM and PHM being 0.80 and 0.90%, respectively. The highest values of CF were recorded by TBM (30.89%) followed by DSM (29.88%) and PHM (20.11%), whereas the lowest value (14.25%) was shown by PBM. The highest NFE values were recorded by PBM and DSM being 56.90 and 55.72% respectively, followed by PHM (39.97%) and the lowest value (26.51%) was shown by TBM.

In general, values of chemical analysis of the tested by-product meals are within the ranges published by many authers **(Tarroni, 1951; Bartocci *et al*, 1980; El-Ghamry, 1993; El-**

Sayed, 1994; Saad, 1998 and Persia *et al*, 2003) for TBM, **(Ghoneim, 1967; Maghraby *et al*, 2001; El-Tawil, 2001 and Faddle, 2003)** for PBM, **(Nour, 1988; Abd El-Hamed, 1988; Zeweil *et al*, 1990; El-Sayed, 1992 and Ali, 1998)** for PHM **(Abdul Rahman *et al*, 1992; Abdel-Megeed, 1993; El-Bogdady, 1995; Hammad, 1996 and Faddle, 2003)** for DSM.

The high CF content in both TBM and DSM is the main factor which limits its use in poultry feeding, whereas, the high CP content in PHM and PBM indicates the possibility of including these by-product meals in poultry diets.

Table (6). Chemical analysis of tested by-product meals (% on DM basis).

Items	TBM	PBM	PHM	DSM
DM	91.71	92.43	88.13	94.69
OM	82.77	90.33	86.72	98.68
CP	22.83	18.38	25.74	07.36
EE	02.54	00.80	00.90	05.72
CF	30.89	14.25	20.11	29.88
NFE	26.51	56.90	39.97	55.72
Ash	17.23	09.67	13.28	01.32

The main chemical constituents of plant cell wall are cellulose, lignin, hemicellulose, pectin and silica. The use of the term CF content in different feed-stuffs does not accurately correlate with its cell wall constituents. Thus, CF content has been widely replaced by a system involving the use of detergent solutions. This system can differentiate between the highly digestible cell contents and the less digestible ones. The ADF is the most suitable estimate of fiber, since it represents the indigestible fraction including cellulose and lignin.

Cell wall constituents of the tested by-product meals are shown in Table (7). The highest NDF fraction (74.11%) was recorded by DSM followed by that of TBM being 73.01%, while PHM and PBM showed the lowest values being 40.63 and 40.21%, respectively. The ADF contents of TBM and DSM achieved the highest values being 52.96 and 49.14%,respectively, whereas, PBM and PHM had the lowest ones (25.75 and 23.37%, respectively). The highest ADL content was recorded by TBM (22.92%) followed by DSM (12.78%) and PBM (10.37%), while PHM showed the lowest one (5.02%) The highest value of cellulose was achieved by DSM (36.36%) followed by TBM (30.04%), while PHM and PBM had nearly similar values being 18.35 and 15.38%,respectively. The hemi-cellulose content ranged between 14.46% in PBM and 24.97% in DSM.

The higher percentage of either cellulose in DSM and TBM or lignin TBM may limit the use of these by-product meals in poultry feeding since these components are the most indigestible contents of the cell wall constituents.

Values of cell wall constituents of tested by-product meals used in the present study are generally within the published ranges reported by **El-Sayed (1994)** for TBM (56.60% ADF, 68.74% NDF, 12.11% hemi cellulose, 27.42% cellulose and 29.90% lignin).

Ghazalah *et al* (2002) revealed that cell wall constituents of PBM were 34.17, 22.76, 11.41, 13.70 and 9.06% for NDF, ADF, hemi-cellulose, cellulose and ADL. **Barreveld (1993)** concluded that NDF, ADF, hemi-cellulose, lignin and cellulose in date pits were 75.0, 57.5, 17.5,11.0 and 42.5%. Whereas, **Ghazalah *et al* (2002)** reported that cell wall constituents (%) for DSM were 75.20 NDF, 58.70 ADF, 16.50 hemi-cellulose, 46.50 cellulose and 12.20 ADL.

Table (7). Cell wall constituents of tested by-product meals (% on DM basis)

Items	TBM	PBM	PHM	DSM
CF	30.89	14.25	20.11	29.88
NDF	73.01	40.21	40.63	74.11
ADF	52.96	25.75	23.37	49.14
ADL	22.92	10.37	05.02	12.78
Cellulose	30.04	15.38	18.35	36.36
Hemi-cellulose	20.05	14.46	17.26	24.97

4.2. Amino Acid Contents of Tested By-Product Meals.

Amino acid contents (as % and g/100g) protein of tested by-product meals are shown in Tables (8 and 9). Comparing amino acid contents (g/100g protein) of tested by-product meals with each other, it is clear that DSM had the highest level of argnine followed by TBM, while PHM showed the lowest one. The highest levels of lysine, histidine and phenylalanine were recorded by TBM followed by PBM, while DSM recorded the lowest levels of these amino acids. Values of leucine, isoleucine, valine and threonine in PBM recorded the highest levels followed by TBM, while DSM showed the lowest levels of leucine and isoleucine and PHM recorded the lowest values for valine and threonine. The highest methionine value was shown by TBM followe by DSM and the lowest one was recorded by PHM. The previous results revealed that TBM and PBM contains better essential amino acids balance than PHM and DSM. Based on broiler chick requirements for essential amino acids **(NRC, 1994)**, the first, second and third limiting amino acids of TBM were threonine, valine and lysine, respectively, and the corresponding ones for PBM were argnine, methionine and lysine. Whereas, valine, argnine and threonine in PHM were the first, second and third limiting amino acids, respectively, and lysine, phenylalanine and threonine were the corresponding ones in DSM (Table 9). Tryptophan was not determined in this study due to the difficulties of its determination.

Generally, results of amino acid contents of the tested by-product meals are within the published ranges of **Hopper (1958), Anwar *et al.* (1978), Brodowski and Geisman (1980) and Persia *et al* (2003)** for TBM; **Gerry (1977) Whittemore *et al.* (1974,1975), Hulan *et al.* (1982a,b) and Ghazalah *et al.* (2002)** for PBM; **Gruhn and Valdivie (1982/1983), Igbasan and Guenter (1994), Igbasan *et al* (1994) and Ali (1998)** for PHM and **Kamel *et al.* (1981), Sawaya *et al.* (1984), Vandepopuliere *et al.* (1995)** and **Ghazalah *et al.* (2002)** for DSM.

Table (8). Amino acid contents (%) of tested by-product meals.

Amino acids	TBM	PBM	PHM	DSM
Argnine	1.49	0.53	0.49	0.72
Lysine	1.19	0.89	0.79	0.17
Histidine	0.87	0.55	0.45	0.13
Phenylalanine	0.87	0.67	0.73	0.12
Leucine	1.36	1.37	1.29	0.34
Isoleucine	0.89	0.83	0.89	0.21
Valine	0.85	0.74	0.29	0.21
Threonine	0.70	0.74	0.47	0.17
Methionine	0.51	0.26	0.27	0.13
Alanine	0.72	1.87	2.28	0.18
Glycine	1.16	0.79	0.92	0.27
Serine	1.03	0.74	0.50	0.21
Cystine	0.42	0.53	1.30	0.12
Proline	1.09	0.76	0.99	0.19
Glutamic acid	3.36	1.48	1.80	0.85
Aspartic acid	2.24	1.58	2.03	0.44

Table (9). Amino acid contents (g/100g protein) of tested by-product meals.

Amino acids	TBM	PBM	PHM	DSM	Broilers requirements (NRC 1994)
Argnine	07.12	03.12	02.16	10.33	05.56
Lysine	05.68	05.24	03.49	02.44	04.73
Histidine	04.15	03.24	01.99	01.87	01.50
Phenylalanine	04.15	03.95	03.22	01.73	03.12
Leucine	06.49	08.07	05.69	04.88	05.17
Isoleucine	04.25	04.89	03.93	03.02	03.45
Valine	04.06	04.36	01.28	03.02	03.89
Threonine	03.34	04.36	02.08	02.44	03.84
Methionine	02.44	01.53	01.19	01.87	01.78
Alanine	03.44	11.01	10.05	02.59	
Glycine	05.54	04.65	04.06	03.88	
Serine	04.92	04.36	02.21	03.02	
Cystine	02.01	03.12	05.73	01.73	
Proline	05.21	04.48	04.37	02.73	
Glutamic acid	16.05	08.72	07.94	12.20	
Aspartic acid	10.70	09.30	08.95	06.32	
FLAA	Threonine	Argnine	Valine	Lysine	
SLAA	Valine	Methionine	Argnine	Phenylalanine	
TLAA	Lysine	Lysine	Threonine	Threonine	

FLAA = First limiting amino acid, SLAA = Second limiting amino acid
TLAA = Third limiting amino acid.

4.3. Feeding Experiments.

Four feeding experiments were carried out to study the effect of feeding different dietary levels of either TBM, PBM, PHM or DSM on growth performance, nutrients digestibility, carcass characteristics, chemical analysis of boneless meat and economic efficiency of broiler chicks.

4.3.1. First feeding experiment (tomato by-product meal).

4.3.1.1. Effect of feeding different dietary levels of tomato by-product meal on growth performance of broiler chicks.

4.3.1.1.1. Live body weight.

Live body weight (LBW) of broiler chicks fed different dietary levels of tomato by-product meal (TBM) at different ages of the experimental period (1–8 weeks of age) are shown in Table (10). Analysis of variance for results obtained are presented in Table (11). The initial LBW of broilers within all treatments at the start of the experiment (1^{st} week of age) was nearly similar (ranged between 138.33 and 141.33g, with no significant differences), Table (11).

At 3 weeks of age, broiler chicks fed 5% TBM recorded the highest LBW (512.00g), while those fed 10% TBM showed the lowest ($P<0.05$) one (260.67g). However, the differences in LBW between broilers fed the control diet and those fed 5%TBM were insignificant, also the differences between chicks of 15% and 20% TBM treatments in LBW were not significant (Tables 10 and 11).

Table (10): Live body weight (g ± SE) of broiler chicks fed different dietary levels of TBM at different ages of the experimental period.

Treatments	Body weight (g)			
	1 week	3 weeks	7 weeks	8 weeks
Control	140.67± 00.88	a 490.33± 28.60	a 1795.67±85.49	b 2165.33± 50.3
5% TBM	141.33± 00.33	a 512.00± 04.93	a 1813.00± 48.87	a 2440.00± 15.44
10% TBM	138.33± 02.73	c 260.67± 05.61	b 976.67± 23.6	c 1138.00± 21.96
15% TBM	139.00± 00.00	b 339.00± 05.29	bc 827.33± 27.1	cd 909.00 ± 08.97
20% TBM	140.00± 01.00	b 341.00± 04.16	c 678.00± 15.1	d 760.67 ± 37.1

SE= Standard error

a, b, c and d: means within the same column with different superscripts are significantly (P<0.05) different.

Table (11): Analysis of variance of live body weight (g) of broiler chicks fed different dietary levels of TBM at different ages of the experimental period.

Source of variance	df	Mean squares and F values							
		1 week		3 weeks		7 weeks		8 weeks	
		MS	F	MS	F	MS	F	MS	F
Treatments	4	4.43	0.77	35002.57	76.88***	892639.43	111.60***	1763770.07	86.01***
Replicates	2	5.07	0.88	936.60	2.06	1661.67	0.21	9123.80	0.44
Error	8	5.73		455.27		7998.33		20506.47	

*** = (P < 0.001)

Results of LBW at 7weeks of age (Tables 10 and 11) revealed that broilers of 5% TBM treatment showed the highest LBW followed by those of the control one, with no significant differences. Whereas, broilers fed 20% TBM recorded the lowest LBW. Chicks fed 10 and 15% TBM recorded nearly similar LBW values, with no significant differences among these two treatments.

At the termination of the experiment (8 weeks of age), broilers fed 5% TBM recorded the highest ($P<0.05$) LBW followed by those fed the control diet, the differences were significant. Whereas, broilers fed 20% TBM showed the lowest LBW. Moreover, the differences in LBW between broilers fed the control diet and those fed either 10, 15 or 20% TBM were significant (Table 10).

4.3.1.1.2. Weight gain.

The effect of dietary treatments on weight gain of broiler chicks at different experimental periods (1 – 3, 3 – 7, 7 – 8 and 1 – 8 weeks of age) are presented in Table (12). The statistical analysis of data obtained are shown in Table (13).

Results of WG during the 1 – 3 weeks of age period (Table 12) showed that broilers fed 5% TBM showed the highest WG followed by those fed the control diet with insignificant differences, whereas those fed 10% TBM recorded the lowest ($P < 0.05$) one, indicating the same trend of LBW at 3 weeks of age. Broilers fed 15 and 20% TBM had nearly similar WG values which were significantly lower than those of both the control and 5% TBM fed chicks.

Table (12): Weight gain (g ± SE) of broiler chicks fed different dietary levels of TBM at different experimental periods.

Treatments	Weight gain (g)			
	1-3 weeks	3-7 weeks	7-8 weeks	1-8 weeks
Control	a 349.67± 27.74	a 1305.33±110.96	ab 369.67± 73.10	b 2024.67± 50.17
5% TBM	a 370.67± 04.67	a 1301.00± 45.65	a 627.00± 154.61	a 2298.67± 154.76
10% TBM	c 122.33± 03.53	b 716.00± 18.01	bc 161.33 02.60	c 999.67± 19.94
15% TBM	b 200.00 05.29	c 488.33± 26.62	c 81.67± 19.03	cd 770.00± 46.14
20% TBM	b 201.00± 03.51	c 337.00± 13.11	c 82.67± 24.10	d 620.67± 37.71

SE= Standard error

a, b, c and d: means within the same column with different superscripts are significantly ($P < 0.05$) different.

Table (13): Analysis of variance of weight gain (g) of broiler chicks fed different dietary levels of TBM at different experimental periods.

Source of variance	df	Mean squares and F values							
		1-3 weeks		3-7 weeks		7-8 weeks		1-8 weeks	
		MS	F	MS	F	MS	F	MS	F
Treatments	4	34264.23	82.26***	615422.10	55.07***	164700.77	8.48**	1759455.07	85.31***
Replicates	2	866.87	2.08	2104.27	0.19	12892.47	0.66	8756.47	0.42
Error	8	416.53		11175.35		19427.47		20624.47	

** = ($P < 0.01$)   *** = ($P < 0.001$)

At 3 – 7 weeks of age period, broilers of the control group and those fed 5% TBM recorded the highest (P<0.05) WG values being 1305.33 and 1301.00g, respectively, whereas those of 15% and 20%TBM treatments showed the lowest (P<0.05) values being 488.33 and 337.00g, respectively. However, the differences in WG between broilers of either the control or 5% TBM treatment and 15% or 20% TBM ones were not significant (Table 12).

During the period of 7 – 8 weeks of age, broilers fed 5% TBM recorded the highest WG value followed by those fed the control diet with no significant differences. Whereas, broilers fed 15% and 20% dietary TBM had the lowest WG values (81.67 and 82.67g, respectively).

Values of WG during the whole experimental period (1–8 weeks of age) were the highest (P<0.05) for 5% dietary TBM fed group, followed by those of the control fed group. Chicks of 20% dietary TBM fed group showed the lowest WG during the whole experimental period and the differences in WG between this group and all other groups were significant except for 15% TBM fed group.

4.3.1.1.3. Feed intake.

Values of feed intake (FI) of broiler chicks fed different dietary levels of TBM at different experimental periods are shown in Table (14), and results of the analysis of variance are illustrated in Table (15).

During the period from 1 – 3 weeks of age, broilers fed 5% TBM consumed the highest amount of FI (666.67g), followed by those fed the control diet (643.67g), with no significant differences among the two treatments. While broilers of the 10% TBM treatment

Table (14): Feed intake (g ± SE) of broiler chicks fed different dietary levels of TBM at different experimental periods.

Treatments	Feed intake (g)			
	1-3 weeks	3-7 weeks	7-8 weeks	1-8 weeks
Control	643.67± 39.84 [a]	2608.67± 135.22 [a]	812.67± 70.89 [b]	4065.00± 158.04 [a]
5% TBM	666.67± 10.52 [a]	2232.00± 206.51 [a]	1057.67± 96.89 [a]	3956.33± 279.02 [ab]
10% TBM	413.33± 02.03 [c]	2182.33± 102.19 [a]	794.00± 20.03 [b]	3389.67± 123.00 [bc]
15% TBM	465.33± 08.97 [bc]	1568.67± 126.49 [b]	745.00± 07.94 [b]	2779.00± 130.22 [cd]
20% TBM	472.33± 08.76 [b]	1388.00± 136.61 [b]	718.33± 41.45 [b]	2578.67± 170.61 [d]

SE= Standard error

a, b, c and d: means within the same column with different superscripts are significantly (P<0.05) different.

Table (15): Analysis of variance of feed intake (g) of broiler chicks fed different dietary levels of TBM at different experimental periods.

Source of variance	df	Mean squares and F values							
		1-3 weeks		3-7 weeks		7-8 weeks		1-8 weeks	
		MS	F	MS	F	MS	F	MS	F
Treatments	4	39517.90	45.74***	763540.73	10.62**	54767.43	5.65*	1351023.73	12.54**
Replicates	2	2122.87	2.46	30393.27	0.42	10998.87	1.13	61171.67	0.57
Error	8	863.95		71929.43		9697.28		107723.58	

* = (P < 0.05) ** = (P < 0.01) *** = (P < 0.001)

consumed the lowest amount of FI (413.33g). However, the differences in FI between both the control and 5% TBM treatments and all other treatments were significant, whereas, those between 15 and 20% TBM treatments were not significant (Table 14).

The highest FI during the period of 3 – 7 weeks of age was recorded by chicks of the control group (2608.67g) followed by those of 5% TBM treatment (2232.00g) then those of 10% TBM treatment (2182.33 g), the differences in FI between the three treatments were not significant. Whereas, the lowest FI (1388.00g) was shown by broilers of 20% TBM treatment followed by those of 15% TBM one (1568.67g) with no significant differences. However, FI of both 20 and 15% TBM treatments were significantly ($P<0.05$) lower than that consumed by chicks of other treatments.

Broiler chicks fed 5% dietary TBM during the period of 7 – 8 weeks of age consumed the highest ($P<0.05$) amount of FI being 1057.67g, whereas values of FI ranged between 718.33 and 812.67g with no significant differences among all other treatments.

Values of FI during the whole experimental period (1 – 8 weeks of age) showed that broilers of the control and 5% TBM treatments consumed the highest amounts of FI being 4065.00 and 3956.33g, respectively, with no significant differences. Whereas, those of 20 and 15% TBM treatments consumed the lowest amounts of FI (2578.67 and 2779.00g, respectively), the differences in FI among these two groups were not significant. However, the differences in FI between broilers fed 10% TBM and those fed either 5% or 15% TBM were not significant.

4.3.1.1.4. Feed conversion.

Feed conversion (FC) of broiler chicks fed different dietary levels of TBM at different experimental periods are presented in Table (16) and analysis of variance of results obtained are shown in Table (17). Broilers fed 5% TBM showed the best FC value (1.80) during the 1 -3 weeks of age period followed by those fed the control diet (1.84), with no significant differences. The poorest ($P<0.05$) FC value was shown by chicks of 10% TBM treatment being 3.38. Broilers fed 15 and 20% TBM recorded nearly similar FC values being 2.33 and 2.35, respectively.

During the period of 3 – 7 weeks of age, also chicks of 5% TBM treatment recorded the best FC value (1.71), followed by those of the control treatment (2.01). Whereas, broilers of 20% TBM treatment showed the poorest ($P<0.05$) FC value being 4.12. However, similar FC values were shown by chicks fed 10 and 15% TBM (3.05 and 3.25, respectively).

Values of FC at the period of 7 - 8 weeks of age cleared that broilers of the 5% TBM treatment recorded the best FC value (1.89) followed by those of the control and 10% TBM treatments being 2.49 and 4.93, respectively, the differences in FC values between these treatments were not significant. While, chicks of 15 and 20% TBM treatments showed the poorest FC values (10.48 and 9.91, respectively), with no significant differences among these treatments.

Table (16): Feed conversion (g feed / g gain ± SE) of broiler chicks fed different dietary levels of TBM at different experimental periods.

Treatments	Feed conversion			
	1-3 weeks	3-7 weeks	7-8 weeks	1-8 weeks
Control	01.84± 00.03 [a]	02.01± 00.08 [a]	02.49± 00.74 [a]	02.01± 00.07 [a]
5% TBM	01.80± 00.01 [a]	01.71± 00.31 [a]	01.89± 00.41 [a]	01.72± 00.02 [a]
10% TBM	03.38± 00.09 [c]	03.05± 00.07 [b]	04.93 00.19 [a]	03.39± 00.05 [b]
15% TBM	02.33± 00.02 [b]	03.25± 00.43 [b]	10.48± 02.95 [b]	03.65 00.37 [bc]
20% TBM	02.35± 00.01 [b]	04.12± 00.38 [c]	09.91± 02.11 [b]	04.16± 00.23 [c]

SE= Standard error

a, b, c and d: means within the same column with different superscripts are significantly (P<0.05) different.

Table (17): Analysis of variance of feed conversion (g feed/g gain) of broiler chicks fed different dietary levels of TBM at different experimental periods.

Source of variance	df	Mean squares and F values							
		1-3 weeks		3-7 weeks		7-8 weeks		1-8 weeks	
		MS	F	MS	F	MS	F	MS	F
Treatments	4	1.22	264.13***	2.59	14.46**	49.26	6.01*	3.41	39.36***
Replicates	2	0.01	1.88	0.29	1.45	8.99	1.10	0.25	2.91
Error	8	0.01		0.20		8.19		0.09	

* = (P < 0.05) ** = (P < 0.01) *** = (P < 0.001)

Results of the whole experimental period (1-8 weeks of age) indicated that the best FC value (1.72) was achieved by chicks fed 5%TBM, followed by those fed the control diet (2.01) with no significant differences between these two treatments. Broilers of 20 and 15% TBM treatments exhibited the poorest FC values (4.16 and 3.65, respectively), followed by those of 10% TBM treatment. However, there were no significant differences in FC values between chicks fed 15% TBM and those fed either 10% or 20% TBM.

The overall results of the effect of dietary TBM levels on broiler chicks performance during the whole experimental period showed that broilers fed 5% TBM recorded the highest LBW and WG values followed by those fed the control diet, while those fed 20% TBM achieved the lowest ones. Moreover, it is clear that both LBW and WG of chicks mostly decreased with increasing the dietary TBM level during all the experimental periods. In agreement with these results, **El-Alialy (1974), Tomczynski (1976) and Garcia and Gonzales (1984)** indicated that various tomato wastes and by-products can be included in small amounts (< 5%) in broiler diets. Larger amounts severely restrict available energy content of the diet due to their high fiber content **(NRC, 1971 and Yannakopoulus *et al.*, 1992). Kelley (1958)** found a superior growth with broilers fed 5% dried tomato seed cake compared with wheat middlings.

Feed intake of broiler chicks tended to decrease with increasing dietary TBM level during all the experimental periods except during the 1-3 weeks of age period which showed a reverse trend. Chicks of the control and 5% TBM treatments consumed the highest amounts of FI and the differences were mostly insignificant.

The best FC values were achieved by chicks fed 5% TBM and the control diet with no significant differences between these two treatments during all the experimental periods, whereas those fed 15 and 20% TBM exhibited the poorest values. In this concern, **Anwar *et al* (1978)** found that FC was significantly depressed with feeding chicks of 4 weeks age a diet containing 34% tomato seed meal when compared with a control diet owing to relatively high fiber of tomato seed meal. However, **Squires *et al.* (1992)** revealed that 10 or 20% dietary tomato pomace did not appreciably depress any measured production parameter (gain, feed to gain ratio and nitrogen utilization) for broiler chicks. Whereas, **Al-Betawi (2005)** reported that LBW, WG, FI and FC values of broiler chicks fed 10% dietary tomato pomace were better and almost significant than those of broilers fed the control diet at 5 weeks of age.

4.3.1.2. Effect of feeding different dietary levels of tomato by-product meal on nutrients digestibility of broiler chicks.

The averages of nutrients digestibility of finisher diets of broiler chicks as affected by dietary treatments at 8 weeks of age are illustrated in Table (18). Analysis of variance of data obtained (Table 19) indicated the presence of significant differences in digestibility values for all nutrients (except NFE digestibility) due to level of TBM effects.

Table (18): Effect of feeding different dietary levels of TBM on nutrients digestibility % of broiler chicks at 8 weeks of age.

Items	Control	5%	10%	15%	20%
DM	84.48± 0.87 [a]	86.38± 2.98 [a]	78.95± 0.60 [b]	74.59± 2.48 [c]	73.93± 0.30 [c]
OM	86.05± 0.74 [a]	87.79± 2.51 [a]	81.59± 0.58 [b]	77.91± 2.12 [c]	75.70± 1.24 [c]
CP	92.08± 0.70 [a]	91.62± 0.60 [a]	88.89± 0.34 [b]	87.00± 0.27 [c]	85.79± 0.08 [d]
EE	92.88± 0.36 [a]	93.20± 0.57 [a]	90.47± 0.19 [b]	87.17± 0.61 [c]	80.28± 1.38 [d]
CF	54.49± 0.34 [a]	53.87± 2.36 [a]	43.96± 1.50 [b]	31.52± 0.77 [c]	23.44± 1.18 [d]
NFE	91.92± 1.66 [ab]	92.75± 1.59 [a]	91.40± 0.85 [ab]	91.29± 1.04 [ab]	90.49± 0.15 [b]

a, b, c and d means within the same raw with different superscripts are significantly (P<0.05) different.

The present results showed that broiler chicks fed 5% TBM recorded the highest digestibility values for most feed nutrients (DM, OM, EE and NFE) followed by those fed the control diet. While, chicks fed 20% TBM showed the lowest digestibility values for all feed nutrients followed by those fed 15% TBM. However, it is clear that nutrients digestibility almost decreased with increasing the dietary level of TBM.

Dry matter digestibility for different finisher diets ranged between 73.93% for the diet containing 20% TBM and 86.38% for that with 5% dietary TBM, while digestion coefficients for OM ranged from 75.70% for broiler chicks fed 20% TBM to 87.79% for those fed 5% TBM, and CP digestibility fluctuated between 85.79% for chicks fed 20% TBM and 92. 08% for birds fed the control diet.

Regarding EE digestibility of different finisher diets, the values varied between 80.28% for broilers fed 20% TBM and 93.20% for those fed the diet with 5% TBM.

The digestion coefficient of CF varied markedly. It ranged from 23 44% for the diet containing 20% TBM to 54.49% for the control diet, whereas, NFE digestibility varied between 90.49% for the diet with 20% TBM and 92.75% for that having 5% dietary TBM.

Digestibility values for the finisher diet contained 10 % TBM in the present study are higher than those reported by **Nagib *et al* (2002)**. They found that the digestion coefficients for the broiler finisher diet contained 10 % tomato waste were 76.33, 76.66, 29.16, 82.03 and 77.01 % for CP, EE, CF, NFE and OM, respectively.

With fish, **Saad (1998)** claimed that tomato waste at 10 % of the diet slightly improved the digestibility of DM.

4.3.1.3. Effect of feeding different dietary levels of tomato by product meal on carcass characteristics and carcass cuts of broiler chicks.

The slaughter weight of chicks varied among the different dietary treatments, therefore to have better base for comparison between different treatments, the carcass characteristics and carcass cuts were calculated as g/100g slaughter weight (i.e carcass characteristics and cuts weights relative to slaughter weight χ 100). Results of carcass characteristics are illustrated in Table (20). Analysis of variance for results obtained (Table 21) revealed that the differences in all carcass characteristics percentages due to dietary treatment effects were significant except for blood, heart and non carcass fat percentages.

The best carcass and edible parts percentages were achieved by chicks fed 5% TBM followed by those fed 10% TBM and the control diet, with no significant differences, whereas, chicks fed 20 and 15% TBM recorded the lowest ones.

Chicks fed 20% TBM showed the highest percentages of blood, feather, inedible parts, liver, gizzard, giblets and empty intestines, whereas, those fed5% TBM recorded the lowest ones except for gizzard percentage.

The highest non carcass fat % was achieved by birds fed 15% TBM and the lowest one was shown by those fed 10% TBM.

Data of various cuts percentages of broilers at 8 weeks of age as affected by different levels of TBM are illustrated in Table (22) and statistical analysis for values obtained are shown in Table (23). The dietary TBM level had significant effect on all carcass cuts% except for wings and total bone percentages.

Chicks fed on 5% TBM recorded the highest hind legs, thigh, drumstick, breast, total meat, breast meat and hind legs meat percentages, and those fed 10 % and 20% TBM achieved the highest wings, total bone and total fat percentages, respectively. Whereas, broilers fed 15% TBM showed the lowest hind legs, thigh, drumstick and hind legs meat percentages and those fed 20% TBM had the lowest breast, wings, total meat and breast meat percentages. The lowest total bone and fat percentages were recorded by chicks fed 5 and 10% TBM, respectively.

In partial agreement with the previous results, **Nagib *et al* (2002)** found that dressing, giblets, blood and feather weights relative to fasted weight of broiler chicks fed diets contained 10 % tomato waste and slaughtered at 7 weeks of age were 69.70, 4.63, 2.55 and 5,56 %, respectively. However, **Orr and Moron (1975) and Hegazay *et al.*(1998)** indicated that the different by-products used in broiler diets had little or no effect on the dressing percentages or edible giblets as long as the diet contained the requirements of protein and energy. **Kamel (1998) and Mohamed (1999)** reported that there were no significant differences in giblets weight percentage for broilers fed diets containing different levels of tomato wastes.

With fish, **Saad (1998)** concluded that using 10 % tomato waste meal in tilapia diets and 5.63 % in carp diets improved the dressing percentage over the control, whereas, **Soltan (2002)** found that replacing 50 % of soybean meal by TBM in tilapia diets did not exert significant effect on the dress-out, by-products and flesh percentages

However, values of carcass characteristics and carcass cuts of the present study are within the ranges reported by **Khirwar *et al* (1980), Abbas (1992), Abdel-malak *et al.* (2001) and Abdel-Azeem (2002)** for broiler chicks.

4.3.1.4. Effect of feeding different dietary levels of tomato by-product meal on chemical composition of broiler chicks meat.

Chemical analysis of broiler chicks meat as affected by different dietary levels of TBM treatments at 8 weeks of age are shown in Table (24). Analysis of variance of data obtained are presented in Table (25). The results revealed that all chemical analysis values were significantly affected by dietary treatments.

The highest moisture percentage was shown by chicks of 10% dietary TBM treatment, while the lowest one was achieved by those of 20% dietary TBM treatment. However, DM percentage showed a reverse trend.

Chicks fed 20% TBM showed the highest CP percentage and those fed the control diet recorded the lowest one. The reverse was true for EE percentage.

Table (24): Effect of feeding different dietary levels of TBM on chemical composition (%) of broiler chicks meat

Items	Control	5 % TBM	10 % TBM	15 % TBM	20 % TBM
Moisture	ab 71.29± 03.84	ab 71.53± 04.58	a 74.12± 01.80	b 69.72± 01.82	b 69.42± 00.63
DM	ab 28.71± 06.64	ab 28.47± 11.52	b 25.88± 05.16	a 30.28± 04.19	a 30.58± 01.43
CP	d 71.41± 00.36	c 74.77± 00.33	c 75.48± 00.69	b 77.55± 00.64	a 78.59± 00.38
EE	a 24.73± 00.32	b 21.02± 01.43	c 19.88± 00.60	d 18.84± 01.06	e 17.58± 01.14
Ash	c 3.86± 01.29	b 4.21± 01.90	a 4.64± 02.37	c 3.61± 05.26	c 3.83± 04.70

a, b, c, d and e: means within each row with different superscripts are significantly (P<0.05) different.

Table (25): Analysis of variance for the effect of feeding different dietary levels of TBM on chemical composition (%) of broiler chicks meat.

Source of variance	df	Mean squares and F values									
		Moisture		DM		CP		EE		Ash	
		MS	F	MS	F	MS	F	MS	F	MS	F
Treatments	4	10.51	12.25**	10.51	12.25**	23.25	131.45***	22.34	634.71***	0.49	29.2***
Replicates	2	1.85	0.40	1.85	0.40	0.03	0.19	0.05	1.42	0.02	1.36
Error	8	4.66		4.66		0.18		0.04		0.02	

** = (P < 0.01) *** = (P < 0.001)

The highest ash content was achieved by chicks of 10% TBM treatment and the lowest one was shown by those of 15% TBM treatment.

In this concern, **Saad (1998)** reported that the inclusion of tomato waste meal in either tilapia or carp diets (10 and 5.63 %, respectively) had no significant effect on whole body composition (moisture, CP, EE and ash contents). Similarly, **Soltan (2002)** found that replacing 50 % of soybean meal by TBM in tilapia diets had no significant effect on moisture and CP contents in fish bodies.

4.3.1.5. Effect of feeding different dietary levels of tomato by-product meal on the economic efficiency of experimental diets.

Results of the effect of feeding different dietary levels of TBM on the economic efficiency of experimental diets are presented in Table (26). Data obtained declared that the price of each Kg of the experimental diets decreased as the level of TBM increased compared to the control diet.

Results in table (26) showed that the diet contained 5% TBM gave the highest economic efficiency value being 2.657 followed by that of the control diet (2.063). Increasing the dietary TBM level from 5% to 10, 15 and 20 % decreased the economic efficiency values of the experimental diets being 0.902, 0.827 and 0.673, respectively.

Considering the relative economic efficiency value of the control diet equals 00, those of other diets were 128.79, 43.72, 40.09 and 32.62 for diets containing 5, 10, 15 and 20% TBM, respectively.

Table (26): Effect of feeding different dietary levels of TBM on the economic efficiency of experimental diets.

Items	Control	5% TBM	10% TBM	15% TBM	20% TBM
Price/kg feed, LE. [(A)]	1.138	1.112	1.085	1.061	1.008
Average FI/chick, kg.	4.065	3.956	3.390	2.779	2.579
Total feed cost, LE.	4.63	4.40	3.68	2.95	2.60
Average WG/chick, kg.	2.025	2.299	1.00	0.770	0.621
Price/kg LBW, LE. [(B)]	7.00	7.00	7.00	7.00	7.00
Total revenue, LE.	14.18	16.09	7.00	5.39	5.35
Net revenue/chick, LE.	9.55	11.69	3.32	2.44	1.75
Feed cost / Kg WG, LE.	2.286	1.913	3.680	3.831	4.187
Economic efficiency, EEf.[(C)]	2.063	2.657	0.902	0.827	0.673
Relative EEf.	100	128.79	43.72	40.09	32.62

A - Based on the price of different ingredients available in the market at the experimental period.

B - According to the local market price at the experimental time.

C - Assuming that the relative EEf of the control diet equals 100.

The lowest feed cost needed to produce one Kg WG was recorded by chicks fed 5% TBM, followed by that achieved by chicks fed the control diet, whereas, values of feed cost needed to obtain one Kg WG increased over the value of the control group with increasing the dietary TBM level more than 5%.

In accordance with the previous results, **Nagib *et al.* (2002)** showed that the inclusion of 10% tomato waste in broiler diets decreased the total feed cost / bird and feed cost / Kg body WG by about 18% and 7%, respectively. Similarly, **Saad (1998)** reported that the inclusion of 10% tomato waste meal in tilapia diets reduced feed cost by about 15%. Also, **Soltan (2002)** found that replacing 50% of soybean meal by TBM in tilapia diets reduced feed costs by 10.93%. The use of tomato waste in carp diets decreased feeding cost by 39% **Khadzhinikolova and Tomasyan (1984).**

4.3.2. Second feeding experiment (potato by-product meal)

4.3.2.1. Effect of feeding different dietary levels of potato by product meal on growth performance of broiler chicks.

4.3.2.1.1. Live body weight.

Average initial and finial LBW of broilers fed the experimental diets at different ages of the experimental period are illustrated in Table (27). Analysis of variance for results obtained are shown in Table (28).

Table (27): Live body weight (g ± SE) of broiler chicks fed different dietary levels of PBM at different ages of the experimental period.

Treatments	Body weight (g)			
	1 week	3 weeks	7 weeks	8 weeks
Control	140.67± 00.88	490.33± 28.60 [a]	1795.67± 85.49 [a]	2165.33± 50.36 [a]
5% PBM	139.67± 00.33	521.67± 12.77 [a]	1760.33± 69.34 [a]	2320.00± 80.31 [a]
10% PBM	139.67± 02.85	389.00± 06.11 [b]	1404.67± 26.42 [b]	1653.33± 49.24 [b]
15% PBM	139.67± 00.33	369.33 03.48 [b]	1306.67± 33.79 [bc]	1582.33± 47.76 [b]
20% PBM	141.00± 00.58	351.00± 19.92 [b]	1142.00± 41.73 [c]	1322.33± 31.22 [c]

SE = Standard error

a, b and c: means within the same column with different superscripts are significantly (P<0.05) different.

Table (28): Analysis of variance of live body weight (g) of broiler chicks fed different dietary levels of PBM at different ages of the experimental period.

Source of variance	df	Mean squares and F values							
		1 week		3 weeks		7 weeks		8 weeks	
		MS	F	MS	F	MS	F	MS	F
Treatments	4	1.27	0.22	17610.73	25.39***	246133.77	31.18***	525411.17	52.29***
Replicates	2	5.07	0.87	1508.87	2.18	15517.27	1.97	3811.67	0.38
Error	8	5.82		693.53		7894.27		10047.42	

*** = (P < 0.001)

Results in Table (27) revealed that the average initial LBW of chicks was nearly similar at the start of the experiment with insignificant differences.

At 3 weeks of age, broiler chicks fed 5% PBM recorded the highest LBW (521.67g) followed by those fed the control diet (490.33g), the differences between these two treatments were not-significant. Whereas, chicks fed 20% PBM achieved the lowest LBW, being 351.00g. However, the differences in LBW between chicks fed 10 or 15% PBM and those fed 20% PBM were insignificant, while the differences between chicks fed either the control diet or 5% PBM and all other treatments were significant (P<0.05).

Values of LBW at 7 weeks of age showed that chicks fed the control diet achieved the highest LBW value followed by those fed 5% dietary PBM being 1795.67 and 1760.33g, respectively, with no significant differences. Whereas, chicks of 20% PBM treatment showed the lowest LBW (1142.00 g). Meanwhile, chicks fed 10% and 15% PBM recorded nearly similar LBW values, with no significant differences.

At 8 weeks of age, chicks fed 5%PBM achieved the highest LBW value (2320.00g) followed by those of the control treatment (2165.33g). While, chicks fed 20% PBM recorded the lowest (P<0.05) LBW being 1322.33 g. Chicks fed 10 and 15% PBM had nearly similar LBW values. However, the differences in LBW of chicks fed either 5% PBM or the control diet and those fed either 10% or 15% PBM were significant (P<0.05).

4.3.2.1.2. Weight gain.

Values of WG of broiler chicks as affected by dietary treatments at different experimental periods (1-3, 3-7, 7-8 and 1-8 weeks of age) are illustrated in Table (29). Results of the analysis of variance are shown in Table (30).

During the period from 1-3 weeks of age, chicks fed 5% PBM and the control treatments recorded the highest WG values being 382.00 and 349.67 g, respectively, the differences were not-significant. Whereas, those fed 20% PBM showed the lowest WG value (210.00g) followed by those fed 15 and 10% PBM (229.67 and 249.33g, respectively), with no significant differences in WG values between these three treatments. However, values of WG of chicks fed 10, 15 or 20% PBM were significantly ($P<0.05$) lower than those of chicks fed either 5% PBM or the control diet.

Similarly, WG values of chicks fed the control diet and 5% PBM during the period from 3-7 weeks of age showed the highest values, with no significant differences. While, those fed 20% PBM achieved the lowest value. Chicks fed 10 and 15% PBM had nearly similar WG values with no significant differences. However, the differences in WG values between chicks fed either the control diet or 5% PBM and those fed 10, 15 or 20% PBM were significant ($P<0.05$).

Broiler chicks fed 5% PBM recorded the highest ($P<0.05$) WG value during the 7-8 weeks of age period, while those fed 20% PBM showed the lowest one. However, there were no significant differences in WG values of chicks fed either 10 or 20% PBM and those fed 20% PBM. Also, the differences in WG values between chicks fed the control diet and those fed either 10 or 15% PBM were not significant.

Table (29): Weight gain (g ± SE) of broiler chicks fed different dietary levels of PBM at different experimental periods.

Treatments	Weight gain (g)			
	1-3 weeks	3-7 weeks	7-8 weeks	1-8 weeks
Control	349.67± 27.74 [a]	1305.33± 110.96 [a]	369.67± 73.10 [b]	2024.67± 50.17 [a]
5% PBM	382.00± 12.74 [a]	1238.00± 70.30 [a]	559.67± 30.69 [a]	2180.33± 80.64 [a]
10% PBM	249.33± 08.88 [b]	1015.67± 26.85 [b]	248.67± 23.33 [bc]	1513.67± 50.60 [b]
15% PBM	229.67± 03.53 [b]	937.33± 31.80 [bc]	275.67± 16.23 [bc]	1442.67± 48.07 [b]
20% PBM	210.00± 19.35 [b]	791.00± 58.81 [c]	180.33± 10.68 [c]	1181.33± 31.67 [c]

SE= Standard error

a, b and c: means within the same column with different superscripts are significantly (P<0.05) different.

Table (30): Analysis of variance of weight gain (g) of broiler chicks fed different dietary levels of PBM at different experimental periods.

Source of variance	df	Mean squares and F values							
		1-3 weeks		3-7 weeks		7-8 weeks		1-8 weeks	
		MS	F	MS	F	MS	F	MS	F
Treatments	4	17659.43	25.94***	136091.23	13.15***	64677.27	14.97***	525850.10	51.62***
Replicates	2	1470.07	2.12	25929.80	2.50	4346.60	1.01	3932.07	0.39
Error	8	680.73		10351.63		4319.52		10187.04	

** = (P<0.01)   *** = (P<0.001)

Values of WG during the whole experimental period (1-8 weeks of age) revealed that chicks fed 5% PBM recorded the highest value being 2180.33g followed by those fed the control diet (2024.67g), with no significant differences. Whereas, those fed 20% PBM achieved the lowest ($P<0.05$) value being 1181.33g. However, chicks fed 10 and 20% PBM had nearly similar WG values being 1513.67 and 1442.67g, respectively. Increasing the dietary PBM level decreased WG values almost significantly.

4.3.2.1.3. Feed intake.

The effect of dietary PBM level on FI of broiler chicks at different experimental periods is presented in Table (31). Analysis of variance for FI values is shown in Table (32).

Feed intake from 1-3 weeks of age showed that chicks fed 5% PBM consumed the highest amount of FI (663.33g), followed by those fed the control diet (643.67g), with no significant differences. Whereas, those fed 20% PBM recorded the lowest FI value (476.67g) followed by those fed 10 and 15% PBM (519.00 and 558.33g, respectively), the differences among these three treatments were not significant.

At 3-7 weeks of age, broilers of 15% PBM treatment consumed the highest amount of FI and those of 20% PBM treatment consumed the lowest amount, the differences between the two treatments were significant. However, the differences in FI consumed by broilers of either 15% or 20% PBM treatments and those consumed by other treatments were not significant.

Table (31): Feed intake (g ± SE) of broiler chicks fed different dietary levels of PBM at different experimental periods.

Treatments	Feed intake (g)			
	1-3 weeks	3-7 weeks	7-8 weeks	1-8 weeks
Control	ab 643.67± 39.84	ab 2608.67± 135.22	cd 812.67± 70.89	a 4065.00± 158.04
5% PBM	a 663.33± 15.67	ab 2471.67± 162.03	a 1129.67± 18.50	a 4264.67± 184.43
10% PBM	c 519.00± 09.85	ab 2713.00± 165.84	bc 924.33 35.09	a 4165.33± 191.95
15% PBM	bc 558.33± 32.64	a 2878.67± 98.44	ab 991.33± 52.13	a 4428.33± 105.95
20% PBM	c 476.67± 27.91	b 2245.00± 19.76	d 708.67± 20.74	b 3430.33± 31.02

SE= Standard error

a, b, c and d: means within the same column with different superscripts are significantly ($P<0.05$) different.

Table (32): Analysis of variance of feed intake (g) of broiler chicks fed different dietary levels of PBM at different experimental periods.

Source of variance	df	Mean squares and F values							
		1-3 weeks		3-7 weeks		7-8 weeks		1-8 weeks	
		MS	F	MS	F	MS	F	MS	F
Treatments	4	19171.43	8.70**	173711.90	2.87*	78770.50	11.28**	437208.07	5.44*
Replicates	2	2521.40	1.14	3912.80	0.06	1304.27	0.19	2400.07	0.03
Error	8	2202.48		60614.05		6983.85		80416.32	

* = ($P< 0.05$) ** = ($P< 0.01$)

Values of feed intake at 7-8 weeks of age revealed that broilers fed 5% PBM consumed the highest amount of FI (1129.67g) followed by those fed 15% PBM (991.33g), with no significant differences. Whereas, those fed 20% PBM recorded the lowest amount of FI followed by those fed the control diet being 708.67 and 812.67g, respectively, the differences were not significant.

Feed intake during the whole experimental period from 1 to 8 weeks of age showed that chicks fed 15% PBM consumed the highest amount of feed (4428.33g), while those fed 20% PBM consumed the lowest ($P<0.05$) amount being 3430.33g. However, there were no significant differences in FI values of chicks fed either the control diet or 5, 10 and 15% dietary PBM

4.3.2.1.4. Feed conversion.

The average FC values (g feed / g gain) of different treatments during the different experimental periods are presented in Table (33) and the statistical analysis for values obtained are shown in Table (34).

Chicks fed 5% dietary PBM and the control diet at 1-3 weeks of age recorded the best FC values being 1.74 and 1.84, respectively. While those fed 15 and 20% dietary PBM showed the poorest FC values (2.43 and 2.29, respectively). The differences in FC values for chicks of 5% PBM and control treatments and all other treatments were significant ($P<0.05$). Whereas, no significant differences were detected between FC values of chicks fed 20% PBM and those fed either 15% or 10% PBM.

Table (33): Feed conversion (g feed / g gain ± SE) of broiler chicks fed different dietary levels of PBM at different experimental periods.

Treatments	Feed conversion (g feed/g gain)			
	1-3 weeks	3-7 weeks	7-8 weeks	1-8 weeks
Control	a 1.84± 00.03	a 2.01± 00.08	a 2.49± 00.75	a 2.01± 00.07
5% PBM	a 1.74± 00.04	a 2.00±00.07	a 2.03± 00.09	a 1.96± 00.03
10% PBM	b 2.08± 00.04	b 2.68± 00.23	b 3.82± 00.54	b 2.76± 00.23
15% PBM	c 2.43± 00.12	b 3.08± 00.18	b 3.60±00.09	b 3.07± 00.13
20% PBM	bc 2.29± 00.08	b 2.87± 00.21	b 3.96± 00.29	b 2.91± 00.10

SE= Standard error

a, b and c: means within the same column with different superscripts are significantly (P<0.05) different.

Table (34): Analysis of variance of feed conversion (g feed/g gain) of broiler chicks fed different dietary levels of PBM at different experimental periods.

Source of variance	df	Mean squares and F values							
		1-3 weeks		3-7 weeks		7-8 weeks		1-8 weeks	
		MS	F	MS	F	MS	F	MS	F
Treatments	4	0.25	18.95***	0.75	9.02***	2.26	3.49*	0.82	13.40**
Replicates	2	0.03	1.87	0.09	1.13	0.28	0.43	0.01	0.17
Error	8	0.01		0.08		0.65		0.06	

* = (P< 0.05)   ** = (P< 0.01)   *** = (P< 0.001)

Results of FC values at 3-7 weeks of age declared that chicks of 5%PBM and control treatments, similarly, achieved the best FC values being 2.00 and 2.01, respectively, while those fed 15% PBM showed the poorest one (3.08). The differences between FC values for chicks of 5% PBM and the control treatments and those of all other treatments were significant, whereas no significant differences were observed in FC values between chicks fed either 10, 15 or 20% PBM.

Values of FC at 7-8 and 1-8 weeks of age periods followed nearly the same trend observed at the period of 3-7 weeks of age. The best FC values were recorded by chicks of 5% PBM and the control treatments and the poorest ones were almost achieved by those of 20 and 15% PBM treatments. The differences in FC values for chicks of 5% PBM and the control treatments and those of all other treatments were significant ($P<0.05$). Whereas, no significant differences were observed in FC values between 10, 15 and 20% PBM treatments.

In general, results of the present study showed that chicks fed 5% PBM recorded the highest LBW values at different ages of the experimental period and those fed 20% PBM achieved the lowest ones. It is clear that LBW values decreased as dietary level of PBM increased. However, no significant differences were detected in LBW values of chicks fed 5% PBM and those fed the control diet.

Averages of WG during the different experimental periods showed the same trend observed with LBW, as averages of WG decreased as dietary PBM level increased. Chicks fed 5% PBM recorded the highest averages of WG, while those fed 20% PBM achieved the lowest ones. However, the differences in WG between chicks fed the control diet and those fed 5%PBM were not significant.

Chicks fed 5% PBM consumed the highest amounts of FI at 1-3 and 7-8 weeks of age periods and those fed 15% PBM recorded the highest amounts of FI at 3-7 and 1-8 weeks of age periods. Whereas, chicks fed 20% PBM consumed the lowest amounts of FI at all experimental periods. However, there were no significant differences in FI consumed by chicks fed the control diet and those fed either 5, 10 or 15% PBM during the whole experiment period.

Chicks fed 5% PBM recorded the best FC values during all experimental periods followed by those fed the control diet, with no significant differences. Whereas, chicks fed higher levels of PBM (10, 15 or 20%) achieved higher (poorest) FC values. The differences in FC values between chicks fed either 5% PBM or the control diet and those fed the higher levels of PBM (10, 15 or 20%) were significant, while increasing the level of dietary PBM from 10 to 15 and 20% had almost no significant effect on FC values.

On the contrary with the present results, **Whittemore *et al.* (1974)** reported that the performance of broilers given diets containing 0, 10 and 20% potato flakes in place of maize meal were similar. Similarly, **Whittemore *et al.* (1974) and (1975)** reported that no significant differences were noticed between the performance of broilers fed diets containing 0, 10 or 20% potato flakes. Feed conversion was not changed and was similar to those in the control and other diets. However, **D' Mello and Whittemore (1975)** concluded that potato flakes enhanced the performance of birds compared with potato starch.

In accordance with the present results, **Gerry (1977)** found that the inclusion of 2, 4 and 8% dehydrated soluble potato solids (DSPS) in broiler diets had little or no effect on growth and feed efficiency of the broilers. Whereas, the inclusion of higher levels of DSPS (12 and 16%) depressed body weight and increased feed efficiency significantly. **Hulan *et al.* (1982a and b)** concluded that potato waste meal (PWM) supplemented with methionine could substitute successfully up to 20%of ground corn in practical poultry diets. **Moustafa (1992)** reported that LBW decreased when dietary potato by-product (PB) level increased in broiler chick diets, the rate of growth was not significant between one-third and one fourth PB levels. Feed efficiency was not significant between the control diet and one-fourth PB level, but the treatment with one third PB recorded highly FI than the control. **Soliman and El-Tawel (2001)** reported that no significant differences were observed between chicks fed the control diet and those consumed the 20% DSPS diet in growth performance.

4.3.2.2. Effect of feeding different dietary levels of potato by-product meal on nutrients digestibility of broiler chicks.

Data for nutrients digestibility of finisher diets for broiler chicks as affected by dietary treatments at 8 weeks of age are illustrated in Table (35). Statistical analysis of data obtained (Table 36) indicated that the differences in digestibility values of all nutrients (DM, OM, CP, EE, CF and NFE) due to treatment effects were significant.

Table (35): Effect of feeding different dietary levels of PBM on nutrients digestibility (%) of broiler chicks at 8 weeks of age.

Items	Control	5%PBM	10%PBM	15%PBM	20%PBM
DM	84.48± 2.98 [a]	87.33± 1.39 [a]	84.56± 2.16 [a]	74.14± 1.21 [b]	72.83± 1.09 [b]
OM	86.05± 0.74 [b]	88.68± 1.21 [a]	84.24± 0.20 [c]	81.51± 0.73 [d]	77.34± 0.62 [e]
CP	92.08± 0.70 [b]	93.06± 0.98 [a]	91.81± 0.69 [b]	89.18± 0.57 [c]	85.08± 0.04 [d]
EE	92.88± 0.36 [a]	93.18± 0.64 [a]	91.29± 1.00 [a]	87.41± 1.13 [b]	92.05± 1.53 [a]
CF	54.49± 0.34 [b]	57.96± 0.40 [a]	51.04± 1.00 [c]	44.77± 1.08 [d]	39.29± 0.66 [e]
NFE	91.92± 1.66 [ab]	94.18± 1.35 [a]	94.00± 1.60 [ab]	90.98± 0.39 [bc]	89.65± 1.50 [c]

a, b, c, d and e: means within the same row with different superscripts are significantly ($P < 0.05$) different.

Digestibility values for different finisher diets ranged between 72.83 % (20% PBM) and 87.33 % (5% PBM) for DM; 77.34 % (20% PBM) and 88.68% (5% PBM) for OM; 85.08 % (20 % PBM) and 93.06 % (5% PBM) for CP; 87.41% (15% PBM) and 93.18 % (5% PBM) for EE; 39.29% (20% PBM) and 57.96 % (5% PBM) for CF and 89.65% (20% PBM) and 94.18% (5% PBM) for NFE. It is clear that the diet contained 5% PBM recorded the highest digestibility values for all feed nutrients followed by the control diet, whereas, the diet contained 20 % PBM achieved almost the lowest ones. Digestibility values for most nutrients of the finisher diets tended to decrease as the dietary PBM level increased. However, the differences in EE digestibility values between diets contained 5, 10 and 20% PBM were not significant.

In agreement with the previous results, **El-Yamny *et al.* (2003)** found that increasing the replacement level from 10 to 25 or 50 % of biscuit, macaroni and bakery by products (instead of yellow corn) in growing Japanese quail diets reduced ($P<0.05$) OM, CP, EE and CF digestibilities. Using dietary bakery by-product improved ($P<0.05$) EE digestibility compared with other by-products. However, using biscuit by-product reduced ($P<0.05$) the digestibility of NFE. Whereas, **Faddle (2003)** reported that digestibility for all nutrients of broiler finisher diets containing 5, 10, 15 and 20% broken potato chips, except CP and NFE ones, tended to increase significantly as broken potato chips level increased. No significant differences were found between treatments for digestibility of NFE. Birds fed the control diet had higher CP digestibility compared to those fed broken potato chips containing diets. However, no significant differences were observed between birds fed broken potato chips containing diets in CP digestibility. Similarly, **Maghraby *et al.* (2001)** indicated that digestibility of the experimental diets were significantly decreased by decreasing the dietary level of potato by-product meal. Moreover, **Vogt and Stute (1969 a, b)** used dried potato shreds (not cooked) in the nutrition of broilers and reported low digestibility coefficients of 0.36 to 0.40 for CP.

4.3.2.3. Effect of feeding different dietary levels of potato by-product meal on carcass characteristics and carcass cuts of broiler chicks.

Data for carcass characteristics of broiler chicks at 8 weeks of age as affected by different dietary levels of PBM are presented in Table (37). Statistical analysis for data obtained are shown in Table (38).

The highest carcass percentage was recorded by chicks of 10 % dietary PBM followed by those fed 5 and 15 % PBM, the differences between the three treatments were not significant, while the lowest percentage was achieved by birds of 20 % dietary PBM. Chicks fed 10 % PBM showed the best edible parts percentage followed by those fed 5 % and 15 % PBM, with no significant differences, whereas, broilers fed 20 % PBM achieved the lowest percentage. The highest blood, feather inedible parts, gizzard, giblets and empty intestines percentages were recorded by chicks fed 20 % PBM, whereas, the lowest percentages of feather and giblets were achieved by those fed 5 % PBM and the lowest blood and inedible parts percentages were shown by chicks fed 10% PBM. Moreover, chicks fed 15 % PBM achieved the highest heart

percentage and those fed 10 % PBM recorded the lowest one. The highest liver and non carcass fat percentages were shown by broilers fed the control diet, whereas, the lowest liver percentage was recorded by those fed 5 % PBM and the lowest non carcass fat percentage was achieved by broilers fed 10 % PBM.

Results presented in Table (38) indicated that the different dietary treatments had significant effect on all carcass characteristics percentages except non carcass fat one.

Results of carcass cuts (Table 39) revealed that chicks fed the diet with 5 % PBM had the highest hind legs, thigh, drumstick, breast, total meat, total bone, breast meat and hind legs meat percentages, whereas, those fed 20 % PBM recorded the lowest respective percentages except drumstick one. The highest wings and total fat percentages were shown by chicks fed 15 and 10 % PBM, respectively, and the lowest ones were achieved by those fed 20 %PBM.

Analysis of variance (Table 40) cleared that all carcass cuts percentages were significantly affected by the level of dietary PBM.

In partial agreement with the previous results, **El-Yamny *et al.* (2003)** reported that incorporating 10% biscuit by-product or 25% bakery by-product in growing Japanese quail diets improved ($P< 0.05$) carcass weight, edible weight and liver weight compared with other dietary treatments. However, increasing all by products (biscuit, macaroni and bakery by-products) replacement up to 50% reduced ($P< 0.05$) carcass weight and weight of edible giblets compared with the control diet. The greatest dressing percent

(P<0.05) was noticed for birds fed dietary biscuit by product at all levels and at 10 % of bakery by-product. Also, **El-Tawil (2001)** reported that the dressed carcass weight percentages of broiler chicks fed on 20 and 40% potato waste diets were higher than that of chicks fed the control diet but the differences were not significant. Total edible meat percentage was not affected by increasing the potato waste level up to 40% in the experimental diets. Abdominal fat percentages were the least with the control diet, while chicks fed on 20 and 40 % potato waste recorded the highest ones. A reverse trend was observed in the case of small intestine, indicating that it was reduced by increasing the dietary potato waste level.

On the other hand, **Job *et al* (1979)** concluded that replacing up to 344.3 g maize / Kg diet with sweet potato had no significant effect on relative weight of body parts (breast, liver, gizzard, heart and lungs) at 10 weeks of age for Rode Island Red chick, and chick of the indigenous fowel of Nigeria. Similarly, **Moustafa (1992)** found that the substitution of yellow corn with potato by-products in broiler rations had no appreciable effect on the dressing percentage of different carcass parts.

4.3.2.4. Effect of feeding different dietary levels of potato by-product meal on chemical composition of broiler chicks meat.

Data for chemical composition of broiler chicks meat as affected by feeding different levels of PBM at 8 weeks of age are shown in Table (41). Analysis of variance for data obtained revealed that dietary treatments had significant effect on CP, EE and ash percentages, whereas the level of PBM had no significant effect on moisture and DM contents (Table 42).

Table (41): Effect of feeding different dietary levels of PBM on chemical composition (%) of broiler chicks meat.

Items	Control	5% PBM	10% PBM	15% PBM	20% PBM
Moisture	71.29±03.48	73.62±00.88	71.95±00.77	73.34±01.38	73.44±00.76
DM	28.71±08.64	26.38±02.44	28.05±01.98	26.66±03.79	26.56±02.09
CP	71.41±00.36 [c]	76.06±01.35 [a]	74.35±00.67 [b]	74.50±00.67 [b]	76.55±00.60 [a]
EE	24.73±00.32 [a]	20.35±00.49 [d]	22.01±02.27 [b]	21.33±00.98 [c]	19.00±01.58 [e]
Ash	3.86±01.29 [bc]	3.59±03.34 [c]	3.64±09.06 [c]	4.17±04.19 [ab]	4.45±01.12 [a]

a,b, c, d and e: means within each row with different superscripts are significantly (P<0.05) different.

Table (42): Analysis of variance for the effect of feeding different dietary levels of PBM on chemical composition (%) of broiler chicks meat.

Source of variance	df	Mean squares and F values									
		Moisture		DM		CP		EE		Ash	
		MS	F	MS	F	MS	F	MS	F	MS	F
Treatments	4	3.28	2.04	3.28	2.04	12.13	44.57***	13.72	208.89***	0.40	14.12**
Replicates	2	1.77	1.10	1.77	1.10	0.75	2.76	0.14	2.10	0.05	1.61
Error	8	1.61		1.61		0.27		0.07		0.03	

** = (P < 0.01) *** = (P < 0.001)

Chicks fed 5% PBM recorded the highest moisture percentage and the lowest DM one, whereas, those fed the control diet showed a reverse trend. The highest CP content was recorded by chicks fed 20 % PBM and the lowest content was achieved by those fed the control diet. Concerning EE content the reverse was true.

Chicks fed the diet of 20% PBM achieved the highest ash percentage, while those fed the diet with 5% PBM showed the lowest one.

In this concern, **Job *et al.* (1979)** reported that values for CP contents of liver, gizzard, heart, lungs and breast were not significantly affected by replacing up to 344.3 g maize / Kg diet with sweet potato, while fat contents were significantly decreased by the replacement of 344.3 Kg maize / Kg diet with sweet potato.

4.3.2.5. Effect of feeding different dietary levels of potato by-product meal on economic efficiency of experimental diets.

Average feed cost / Kg WG and economic efficiency for the experimental diets containing different dietary levels of PBM are shown in Table (43). The highest price of one Kg feed was shown by the diet having 5 % dietary PBM followed by the control diet, while the price of each Kg of the other experimental diets decreased with increasing the dietary level of PBM, the diet contained 20% PBM showed the lowest one.

Values of feed cost / Kg WG showed that the control diet achieved the lowest one followed by the diet contained 5% PBM being 2.286 and 2.307, LE respectively, whereas, the diet contained 15% PBM showed the highest feed cost /Kg WG (3.243 LE).

Table (43): Effect of feeding different dietary levels of PBM on the economic efficiency of experimental diets.

Items	Control	5% PBM	10% PBM	15% PBM	20% PBM
(A) Price/kg feed, LE.	1.138	1.180	1.056	1.057	1.029
Average FI / chick , Kg.	4.065	4.265	4.165	4.428	3.430
Total feed cost, LE.	4.63	5.03	4.40	4.68	3.53
Average WG/chick , Kg.	2.025	2.180	1.514	1.443	1.181
(B) Price/kg LBW, LE.	7.00	7.00	7.00	7.00	7.00
Total revenue, LE.	14.18	15.26	10.60	10.10	8.27
Net revenue/chick, LE.	9.55	10.23	6.20	5.42	4.74
Feed cost / Kg WG, LE.	2.286	2.307	2.906	3.243	2.989
Economic efficiency, EEf.	2.063	2.034	1.409	1.158	1.343
(C) Relative EEf.	100	98.59	68.30	56.13	65.10

A - Based on the price of different ingredients available in the market at the experimental period.

B - According to the local market price at the experimental time.

C - Assuming that the relative EEf of the control diet equals 100.

Results in Table (43) indicated that diets recorded the lowest feed cost / Kg WG values, achieved the highest (best) EEf values. Therefore, the control diet showed the best economic feed efficiency value (2.063) followed by the diet contained 5 % PBM (2.034), while, the diet having 15% PBM which recorded the highest feed cost / Kg WG, achieved the lowest (poorest) economic feed efficiency value being 1.158.

Considering that the EEf value of the control diet equals 100, the relative EEf values for diets containing 5, 10, 15 and 20 % PBM will be 98.59, 68.30, 56.13 and 65.10, respectively, indicating that the diet containing 5% PBM achieved the best value among the different treatments.

Similar results were reported by **El-Tawel (2001).** He found that the cost of one Kg ration decreased by increasing the potato waste replacement (20 and 40%) in the experimental diets. However, chicks fed the control (corn soybean meal) diet during the whole experimental period recorded the highest economic efficiency followed by those fed the 20 % potato waste diet. **Faddle (2003)** concluded that the use of broken potato chips in broiler diets (5, 10, 15 and 20%) resulted in lower feed cost than the control diet. Moreover, feeding birds on diets containing broken potato chips showed higher economic efficiency as compared to those fed the control diet. He concluded that, from the economical point of view, using broken potato chips up to 20 % to replace a part of yellow corn in broiler chick diets, improved the profitability without any adverce effects of productive performance of broiler chicks.

With laying hens, **Maghraby *et al.* (2001)** reported that potato by-product meal could be used to replace a part of yellow corn up to 50 % in laying hen diets without detrimental effect on performance and quality of eggs as indicated by the economic efficiency values.

Yamny *et al.* (2003) found that the inclusion of biscuit, macaroni and bakery by products as substitute of maize at levels of 10, 25 and 50 % of each by product in growing Japanese diets had no deteriorated effects on economic efficiency of quail. The greatest economic efficiency values were for diets contained 50 and 10% biscuit by-product or 25% bakery by-product.

Soltan (2002) reported that replacing 40 % of yellow corn by potato by-product meal in tilapia diets reduced feed costs by 7.33%. Similarly, **Ghazalah *et al.* (2002)** concluded that replacing corn energy by 50% potato by-product meal in Nile tilapia fish decreased feed cost needed to obtain one Kg of live weight gain.

4.3.3. Third feeding experiment (pea hulls meal).

4.3.3.1. Effect of feeding different dietary levels of pea hulls meal on growth performance of broiler chicks.

4.3.3.1.1. Live body weight.

Results in Table (44) showed the effect of different levels of PHM on average LBW of broiler chicks at different ages of the experimental period. Statistical analysis of these results are presented in Table (45).

Data in Table (44) revealed that all chicks have commenced with a nearly similar initial LBW with no significant differences.

Table (44): Live body weight (g ± SE) of broiler chicks fed different dietary levels of PHM at different ages of the experimental period.

Treatments	Body weight (g)			
	1 week	3 weeks	7 weeks	8 weeks
Control	140.67±0.88	483.67± 34.42 a	1795.67± 85.49 a	2165.30± 50.36 a
5% PHM	140.33± 0.88	428.33± 2.91 a	1745.00± 51.60 a	2138.00± 39.95 a
10% PHM	140.00± 1.00	352.00± 4.36 b	1133.00± 30.89 b	1335.33± 23.60 b
15% PHM	140.33± 0.88	271.00± 8.39 c	736.33± 31.43 c	871.33± 36.55 c
20% PHM	140.33± 0.67	258.67± 4.63 c	774.00± 37.45 c	904.33± 46.37 c

SE= Standard error

a, b and c: means within the same column with different superscripts are significantly ($P<0.05$) different.

Table (45): Analysis of variance of live body weight (g) of broiler chicks fed different dietary levels of PHM at different ages of the experimental period.

Source of variance	df	Mean squares and F values							
		1 week		3 weeks		7 weeks		8 weeks	
		MS	F	MS	F	MS	F	MS	F
Treatments	4	0.17	0.06	28656.23	31.66***	784518.27	78.80***	1219050.27	211.07***
Replicates	2	0.07	0.02	292.07	0.32	126.60	0.01	1422.87	0.25
Error	8	2.82		904.98		9955.27		5775.62	

*** = ($P < 0.001$)

Average LBW of chicks at 3 weeks of age showed that chicks fed the control diet recorded the highest LBW followed by those fed 5% PHM, with no significant differences. Whereas, chicks fed 20% PHM achieved the lowest LBW followed by those fed 15% PHM, the differences in LBW between these two treatments were not significant. However, the differences in LBW between chicks fed either the control diet or 5% dietary PHM and those fed other levels of PHM were significant. Also, the differences in LBW of chicks fed 20% or 15% PHM and those fed other levels of PHM were significant.

Values of LBW at 7 and 8 weeks of age followed the same trend observed at 3 weeks of age. The highest LBW value was achieved by chicks fed the control diet followed by that recorded by chicks fed 5%PHM, with no significant differences. Whereas, the lowest LBW value was recorded by chicks fed 15% PHM followed by that achieved by chicks fed 20% PHM, the differences between the two levels of PHM in LBW were not significant. Similarly, the differences in LBW for chicks of the control or the 5% dietary PHM treatments and all other treatments were significant. Also, the differences in LBW for chicks of 15 and 20% PHM treatments and all other treatments were significant.

4.3.3.1.2. Weight gain.

The highest WG at 1-3 weeks of age was shown by chicks fed the control diet followed by that of birds fed 5% PHM, being 343.00 and 288.00g, respectively, the differences were not significant. While, the lowest WG was achieved by chicks fed 20% PHM followed by that of birds fed 15% PHM (118.33 and 130.67g, respectively), with no significant differences between the two levels of PHM in WG. However, WG values of chicks fed either the control diet or 5% PHM were significantly (P<0.05) higher than those of chicks fed other levels of PHM (10, 15 and 20%) as shown in Tables (46) and (47).

Results of WG at 3-7 weeks of age showed that chicks fed 5% dietary PHM recorded the highest WG value (1316.67g) followed by those fed the control diet (1312.00g), with no significant differences. Whereas, broilers fed 15% PHM achieved the lowest value (465.33g) followed by that of broilers fed 20% PHM (515.33g), the differences were not significant.

Values of WG at 7-8 weeks of age revealed that the highest value (393.00g) was achieved by chicks fed 5% PHM followed by that of chicks fed the control diet, being 369.67g, with no significant differences. Increasing the dietary level of PHM from 5 to 10, 15 and 20% decreased WG values of chicks in descending order with significant (P<0.05) differences compared with values of 5% PHM and the control treatments.

Data of WG values at the whole experimental period (1-8 weeks of age) followed nearly the same trend noticed at 3-7 weeks of age as chicks fed the control diet showed the highest WG value 2024.67g followed by those fed 5% PHM being 1997.67g, with no significant differences. Whereas, chicks fed 15% PHM recorded the lowest value (731.00g) followed by that of birds fed 20% PHM (764.00g) and the differences were not significant. It is clear that increasing dietary PHM level more than 5% almost decreased WG values obtained

Table (46): Weight gain (g ± SE) of broiler chicks fed different dietary levels of PHM at different experimental periods.

Treatments	Weight gain (g)			
	1-3 weeks	3-7 weeks	7-8 weeks	1-8 weeks
Control	a 343.00± 33.55	a 1312.00± 114.84	a 369.67± 73.10	a 2024.67± 50.17
5% PHM	a 288.00± 2.08	a 1316.67± 49.46	a 393.00± 17.21	a 1997.67± 39.73
10% PHM	b 212.00± 4.36	b 781.00± 33.62	b 202.33± 30.60	b 1195.33± 24.39
15% PHM	c 130.67± 6.02	c 465.33± 35.33	b 135.00± 5.20	c 731.00± 35.73
20% PHM	c 118.33± 4.10	c 515.33± 36.36	b 130.33± 10.17	c 764.00± 46.49

SE= Standard error

a, b and c: means within the same column with different superscripts are significantly ($P<0.05$) different.

Table (47): Analysis of variance of weight gain (g) of broiler chicks fed different dietary levels of PHM at different experimental periods.

Source of variance	df	Mean squares and F values							
		1-3 weeks		3-7 weeks		7-8 weeks		1-8 weeks	
		MS	F	MS	F	MS	F	MS	F
Treatments	4	28590.57	33.08***	519010.73	35.89***	48381.73	10.00**	1218635.43	212.13***
Replicates	2	283.40	0.33	198.87	0.01	769.07	0.16	1408.07	0.25
Error	8	864.32		14462.28		4838.23		5744.73	

** = ($P < 0.01$)   *** = ($P < 0.001$)

4.3.3.1.3. Feed intake.

Data in Table (48) showed the effect of dietary PHM level on FI of broiler chicks at different experimental periods, and the analysis of variance for values obtained are given in Table (49).

Averages of FI at 1-3 weeks of age revealed that chicks fed the control diet consumed the highest (P<0.05) amount of FI (643.67g), followed by those fed 5% PHM (562.67g). Values of FI deceased gradually with increasing dietary PHM level from 5 to 10, 15 and 20%. However, the differences in FI between chicks fed 5% PHM and those fed either 10, 15 or 20 % PHM were significant, while the differences in FI among 10, 15 and 20% PHM treatments were not significant.

Chicks fed the control diet consumed the highest (P<0.05) amount of FI at 3-7, 7-8 and 1-8 weeks of age periods, while those fed 15% PHM consumed the lowest amount at the same respective periods. However, the level of dietary PHM had no significant effect on FI values during 3-7, 7-8 and 1-8 weeks of age periods.

4.3.3.1.4. Feed conversion

Results in Table (50) showed that chicks fed the control diet at 1-3 weeks of age recoded the lowest (best) FC value (1.89 g feed / g gain), followed by those fed 5% PHM (1.95) and 10% PHM (2.27), while chicks fed 20 and 15% PHM showed the highest (poorest) values, being 3.91 and 3.66, respectively. These results indicated that increasing the dietary PHM level had an adverse effect on FC values. No significant differences were detected in FC values between chicks fed the control diet and those fed either 5 or 10% PHM. Also, the differences in FC values between chicks fed 15% PHM and those fed 20% PHM were not significant. Whereas, increasing the dietary PHM level from 5 or 10% to 15 or 20% significantly (P<0.05) increased FC values (Tables 50 and 51).

Table (48): Feed intake (g ± SE) of broiler chicks fed different dietary levels of PHM at different experimental periods.

Treatments	Feed intake (g)			
	1-3 weeks	3-7 weeks	7-8 weeks	1-8 weeks
Control	643.67± 39.84 [a]	2608.67±135.22 [a]	812.67± 70.89	4065.00± 158.04 [a]
5% PHM	562.67± 12.14 [b]	2221.33± 2043 [b]	723.33± 112.29	3507.33± 86.53 [b]
10% PHM	481.67± 20.35 [c]	2120.00± 48.77 [b]	705.33± 18.55	3307.00± 84.13 [b]
15% PHM	474.00± 7.0 [c]	2101.33± 72.99 [b]	674.33± 13.37	3249.67± 81.61 [b]
20% PHM	461.33± 6.77 [c]	2114.00± 40.53 [b]	720.33± 29.87	3295.67± 59.33 [b]

SE= Standard error

a, b and c: means within the same column with different superscripts are significantly ($P<0.05$) different.

Table (49): Analysis of variance of feed intake (g) of broiler chicks fed different dietary levels of PHM at different experimental periods.

Source of variance	df	Mean squares and F values							
		1-3 weeks		3-7 weeks		7-8 weeks		1-8 weeks	
		MS	F	MS	F	MS	F	MS	F
Treatments	4	18024.17	14.06**	139145.73	7.15**	7979.77	0.87	344858.73	11.86**
Replicates	2	1604.87	1.25	6278.87	0.32	18944.60	1.98	32829.07	1.13
Error	8	1281.62		19468.53		9551.77		29084.73	

** = ($P < 0.01$).

Table (50): Feed conversion (g feed / g gain ± SE) of broiler chicks fed different dietary levels of PHM at different experimental periods.

Treatments	Feed conversion			
	1-3 weeks	3-7 weeks	7-8 weeks	1-8 weeks
Control	a 1.89± 0.07	a 2.00± 0.09	b 2.49± 0.75	a 2.01± 0.07
5% PHM	a 1.95± 0.04	a 1.69± 0.06	a 1.83± 0.24	a 1.76± 0.08
10% PHM	a 2.27± 0.05	b 2.73± 0.18	c 3.64± 0.53	b 2.77± 0.09
15% PHM	b 3.66± 0.25	c 4.55± 0.20	d 5.00± 0.10	c 4.46± 0.14
20% PHM	b 3.91± 0.18	c 4.14± 0.24	d 5.58± 0.39	c 4.34± 0.20

SE= Standard error

a, b, c and d: means within the same column with different superscripts are significantly (P<0.05) different.

Table (51): Analysis of variance of feed conversion (g feed/g gain) of broiler chicks fed different dietary levels of PHM at different experimental periods.

Source of variance	df	Mean squares and F values							
		1-3 weeks		3-7 weeks		7-8 weeks		1-8 weeks	
		MS	F	MS	F	MS	F	MS	F
Treatments	4	2.84	45.87^{***}	4.85	66.62^{***}	7.63	9.88^{**}	4.84	114.15^{***}
Replicates	2	0.07	1.18	0.13	1.79	0.06	0.08	0.06	1.43
Error	8	0.06		0.07		0.77		0.04	

** = (P < 0.01) *** = (P < 0.001)

The best FC values at 3-7 weeks of age were recorded by chicks of 5% PHM and the control treatments, being 1.69 and 2.00, respectively, with no significant differences between the two treatments. Whereas, chicks fed 15 and 20% PHM achieved the poorest FC ones (4.55 and 4.14 respectively) and the differences between the two levels of PHM in FC values were also not significant. However, increasing the dietary PHM level from 5% to either 10, 15 or 20% significantly ($P<0.05$) increased (adverse) FC values.

Values of FC at 7-8 weeks of age cleared that chicks fed 5% PHM showed the best ($P<0.05$) FC value (1.83) followed by those fed the control diet being 2.49, with significant differences. Increasing the dietary PHM level from 5% to either 10, 15 or 20% significantly ($P<0.05$) adversed FC values. Whereas, there were no significant differences in FC values between chicks fed 15% PHM and those fed 20% PHM.

Results of FC values for the whole experimental period (1-8 weeks of age) showed a trend similar to that noticed at 3-7 weeks of age. Chicks fed 5% PHM and the control diet achieved the best FC values, being 1.76 and 2.01, respectively, with no significant differences. Whereas, chicks fed 15 and 20% PHM recorded the poorest ones (4.46 and 4.34, respectively) and the differences between the two treatments were not significant. However, feed conversion values increased with increasing the dietary PHM level and the differences were mostly significant (Table 50).

Results of this experiment indicated that the highest LBW and WG values were recorded by chicks fed the control diet and 5% PHM at all experimental periods. Increasing the dietary PHM level had an adverse effect on both traits and the differences were almost significant.

In agreement with the present results, **Ali (1998)** reported that both LBW and WG of chicks, mostly decreased with increasing the dietary pea by-product (PBP) level (5, 10 and 15%) during all the experimental periods (1-4, 4-7 and 1-7 weeks of age). Chicks fed 15% PBP recorded the lowest LBW and WG values. The differences in averages of either LBW and WG between chicks fed the control diet and those fed up to 10% PBP were almost non-significant during all the experimental periods. **Khirwar *et al* (1980)** using different levels of pea waste (0, 2.5, 5.0, 7.5 and 10.0%) in chickens diet, reported that the increase in pea waste level up to 10% improved LBW at 10 weeks of age. Similar results were mentioned by **Udedibie and Igwe (1989).** However, **Paliwal *et al.* (1980)** found that the addition of pea waste up to 20%in chicks diet improved average body weight at 10 weeks of age. Whereas, **Igbasan and Guenter (1994)** reported that body weight was not significantly different among chicks fed diets containing 0 and 15% PBP, increasing PBP chips (30 and 45%) resulted in significantly poorest growth rate.

Results of FI showed that chicks fed the control diet consumed the highest ($P<0.05$) amount of FI during all the experimental periods followed by those fed 5% PHM. However, the amount of feed consumed by chicks tended to decrease with increasing the dietary PHM level but the differences were mostly non-significant. In contrast with the previous results, **Ali (1998)** reported that FI of broiler chicks tended almost to increase with increasing PBP level in the diet during all experimental periods.

The differences in FI between chicks fed the control diet and those fed 5% PBP were not significant at the starting period. Whereas, the differences in FI of the control and most PBP dietary levels were not significant at the finishing and entire periods. Similarly**,** **Khirwar *et al.* (1980) and Zeweil *et al.* (1990)** found that feed consumption increased progressively with increasing dietary PBP level. Whereas, **Udedibie and Igwe (1989)** and **Igbasan *et al.* (1994)** reported that feed consumption of broiler chick was generally similar among diets containing up to 10% PBP.

The best FC values during all experimental periods were recorded almost by chicks fed 5% PHM followed by those fed the control diet, with no significant differences between the two treatments. Increasing the dietary PHM level had detrimental effect on FC values. The poorest values ($P < 0.05$) were recorded by chicks fed 15 and 20% PHM during all experimental periods.

In accordance with the present results, **Ali (1998)** indicated that increasing the dietary level of PBP had detrimental effect on FC values of broiler chicks. The best FC values were recorded by chicks of the control diet, while the poorest ones were achieved by those fed 15% PBP during all experimental periods. However, the differences in FC values between chicks fed the control diet and those fed 5% PBP at the starting period were not significant. Whereas, the differences between values of the control diet and those of most experimental treatments were not significant during the finishing and entire periods. **Khirwar *et al.* (1980)** reported that the 10% pea waste level had better FC value compared favorably with that of the control. Similarly, **Zeweil *et al.* (1990)** found that birds fed low levels of PBP (0, 4 or 8%) had better FC values than those fed higher levels. However, **Paliwal *et al.* (1980**) mentioned that increasing pea waste level up to 20% improved FC values. While, **Igbasan and Guenter (1994)** reported that increasing the dietary PBP level over 15% resulted in significantly poor feed efficiency values.

4.3.3.2. Effect of feeding different dietary levels of pea hulls meal on nutrients digestibility of broiler chicks.

Digestibility values (DM, OM, CP, EE and NFE) of finisher diets for broiler chicks as affected by dietary levels of PHM at 8 weeks of age are presented in Table (52). Results obtained showed that the level of dietary PHM had significant effect on digestibility of all nutrients (Table 53).

The present results showed that chicks fed the diet with 5 % dietary PHM recorded the highest digestibility values for all nutrients except NFE digestibility, whereas those fed the diet contained 20% PHM achieved the lowest DM, OM, CP and CF digestibilities. The highest NFE digestibility value was shown by broilers fed 20 % dietary PHM and the lowest one was recorded by chicks fed the control diet. While, chicks fed 15 % PHM recorded the lowest EE digestibility.

The differences in DM, OM, CP digestibilites for chicks fed the control diet and those fed 5 % PHM were significant ($P < 0.05$), whereas the differences in digestibility of most feed nutrients (DM, OM, CP and NFE) for chicks fed the control diet and those fed 10 % PHM were not significant. However, increasing the dietary PHM level from 5% to 10, 15 or 20% almost decreased the digestibility values of feed nutrients.

Table (52): Effect of feeding different dietary levels of PHM on nutrients digestibility (%) of broiler chicks at 8 weeks of age.

Items	Control	5% PHM	10% PHM	15% PHM	20% PHM
DM	84.48± 0.87 [b]	87.06± 0.49 [a]	84.75± 1.12 [b]	83.38± 0.31 [c]	81.73± 0.96 [d]
OM	86.05± 0.74 [b]	88.30± 0.37 [a]	86.49± 1.06 [b]	86.04± 0.20 [b]	83.03± 1.79 [c]
CP	92.08± 0.70 [b]	93.60± 0.60 [a]	91.25± 0.55 [b]	89.69± 0.76 [c]	85.37± 0.18 [d]
EE	92.88± 0.36 [a]	93.31±0 .23 [a]	87.11± 2.64 [b]	85.61± 2.52 [b]	87.44± 0.07 [b]
CF	54.49± 0.34 [a]	56.46± 1.39 [a]	49.54± 1.18 [b]	44.33± 1.19 [c]	39.25± 0.91 [d]
NFE	91.92± 1.66 [b]	93.63± 0.18 [b]	93.22± 0.15 [b]	92.98± 0.16 [b]	95.42± 0.92 [a]

a, b, c, d : means within the same row with different superscripts are significantly ($P < 0.05$) different.

With regard to digestibility of pea hulls meal, **El-Sayed (1992)** reported that digestibility values of pea hulls were 47.92, 78.79, 93.78, 26.43 and 52.28 % for OM, CP, EE, CF and NFE, respectively. Whereas, **Zeweil (1992)** found that digestibility values for pea by-product were 74.68, 75.10, 70.54, 19.02 and 81.85 % for OM, CP, EE, CF and NFE, respectively.

Bonomi *et al.* (1985) reported that digestibilities of DM, OM, crude energy, CP and CF of dried pea fodder were 60.50, 67.74, 64.98, 63.00 and 51.06 %, respectively.

4.3.3.3. Effect of feeding different dietary levels of pea hulls meal on carcass characteristics and carcass cuts of broiler chicks.

Results in Table (54) showed the effect of different PHM on carcass characteristics of broiler chicks at 8 weeks of age. Statistical analysis of these results are presented in Table (55).

Chicks fed the diet with 5% PHM recorded the best carcass and edible parts percentages followed by those fed the control diet, while chicks fed 15 % dietary PHM achieved the lowest percentages for these two traits. The highest heart and liver percentages were shown by chicks fed the control diet and the lowest ones were recorded by chicks fed 15 % 5PHM. Chicks fed the diet containing 20 % PHM achieved the highest feather, gizzard, giblets, and empty intestines percentages, where the lowest ones (except empty intestines %) were recoded by those fed the control diet. The highest inedible parts and non carcass fat percentages were achieved by chicks fed 15 % PHM and the lowest ones were recorded by those fed 5% and 10 % PHM, respectively. Chicks fed 10 % PHM showed the highest blood percentage and those of 5 % dietary PHM had the lowest one.

Results in Table (55) indicated that the differences in all carcass percentages due to level of PHM effect were not significant except for blood, gizzard, and empty intestines percentages.

Data in Table (56) revealed that broilers of 5 % PHM treatment recorded the highest percentages of all carcass cuts studied except for wings and total bone ones. The highest wings percentage was shown by birds of 20 % PHM treatment and the lowest one was achieved by those of 15 % PHM treatment. Whereas, chicks of the control recorded the highest total bone percentage and those of 15 % PHM treatment had the lowest one. The lowest drumstick, breast, total meat, breast meat and hind legs meat percentages were recoded by chicks of 20 % PHM treatment, the lowest hind legs and thigh percentages were shown by birds of 15 % PHM.

Data in Table (57) indicated that dietary treatments had significant effect on all carcass cuts percentages studied except thigh, wings and total bone ones.

In accordance with the previous results, **Khirwal *et al.* (1980)** found that different levels of pea waste (2.5, 5.0, 7.5 and 10.0 %) had no significant effect on the dressing percentage of broiler chickens at 10 weeks of age. Also, **Paliwal *et al.* (1980)** reported that carcass dressing percentage was 70.49, 70.67, 71.80 and 71.73 for broiler chicks fed diets with 0, 10, 15 and 20 % dehydrated pea waste at 10 weeks of age. Indicating that different levels of dehydrated pea waste had little effect on carcass dressing percentage of broilers. Similarly, **Ali (1998)** concluded that the different dietary levels of pea by-product (5, 10 and 15%) had no significant effect on both carcass and dressing percentages of broiler

chicks at 7 weeks of age. Various organs percentages (liver, gizzard, heart and empty small intestine) varied slightly according to level of dietary pea by-product but the differences were unsizable and most likely non-significant.

Zeweil *et al.* (1990) reported that diets containing 0, 4, 8, 12 and 16% pea by-product had no significant effect on percentages of dressed carcass, heart, liver, gizzard, kidney and abdominal fat of Peking ducklings at 10 weeks of age. Ducks fed 16 % pea by-product had significantly ($P < 0.05$) higher gizzard percentage than the other treatments.

With rabbits, **Grandi and Angelis (1983)** found no significant differences in dressing percentage among groups of California χ New Zealand White rabbits fed diets without or with dried waste from the pea processing industry (5 to 10 %) at 77 days of age. Similarly, **Zeweil (1992)** with Flander rabbits fed diets without or with 12.5, 25.0 or 50.0 % pea by-product for 6 weeks, found no differences in slaughter yield among control rabbits and those receiving 12.5 % pea by-product. Whereas, slaughter yield decreased ($P < 0.05$) significantly when the diet of rabbits contained 50 % pea by-product. Weights of the small intestine and caecum expressed as percentages of body weight, increased with the added pea by-product.

4.3.3.4. Effect of feeding different dietary levels of pea hulls meal on chemical composition of broiler chicks meat.

Results for the effect of feeding different dietary levels of pea hulls meal on chemical composition of broiler chicks meat at 8 weeks of age are shown in Table (58). Statistical analysis of results obtained indicated that the differences in chemical analysis of all nutrients due to treatments effect were significant (Table 59).

Table (58): Effect of feeding different dietary levels of PHM on chemical composition (%) of broiler chicks meat.

Items	Control	5 % PHM	10% PHM	15% PHM	20% PHM
Moisture	71.29± 03.48 [b]	73.97± 00.44 [a]	74.90± 00.13 [a]	70.96± 01.01 [b]	72.85± 00.07 [ab]
DM	28.71± 08.64 [a]	26.03± 01.26 [b]	25.10± 00.40 [b]	29.04± 02.46 [a]	27.15± 00.18 [ab]
CP	71.41± 00.36 [c]	71.20± 00.21 [c]	73.48± 00.27 [b]	73.71± 00.41 [b]	75.47± 00.66 [a]
EE	24.73± 00.32 [b]	25.42± 01.10 [a]	21.34± 00.94 [d]	22.49± 00.89 [c]	20.40± 01.03 [e]
Ash	03.86± 01.29 [c]	03.38± 05.26 [d]	05.18± 01.93 [a]	03.80± 03.95 [d]	04.13± 01.94 [b]

a, b, c, d and e :means within each raw with different superscripts are significantly (P<0.05) different.

Table (59): Analysis of variance for the effect of feeding different dietary levels of PHM on chemical composition (%) of broiler chicks meat.

Source of variance	df	Mean squares and F values									
		Moisture		DM		CP		EE		Ash	
		MS	F	MS	F	MS	F	MS	F	MS	F
Treatments	4	8.59	5.44*	8.59	5.44*	9.44	113.11***	13.91	353.25**	1.37	171.66***
Replicates	2	0.47	0.30	0.47	0.30	0.14	1.63	0.05	0.30	0.04	1.14
Error	8	1.58		1.58		0.08		0.04		0.01	

* = (P < 0.05)   *** = (P < 0.001)

The highest moisture percentage was achieved by chicks of 10 % dietary PHM treatment, while the lowest one was recorded by chicks of 15 % dietary PHM treatment. The DM content showed a reverse trend as chicks fed 15 % PHM had the highest content and those fed 10 % PHM recorded the lowest content.

Chicks fed the diet containing 20% PHM achieved the highest CP percentage and the lowest EE one, whereas those fed the diet having 5 % PHM showed the highest EE percentage and the lowest CP one.

The highest ash content was recorded by chicks of 10% dietary PHM treatment and the lowest one was shown by birds of 5 % dietary PHM treatment.

4.3.3.5. Effect of feeding different dietary levels of pea hulls meal on economic efficiency of experimental diets.

The effect of different dietary levels of PHM on the economic efficiency of experimental diets is presented in Table (60). Results obtained showed that the control diet recorded the highest price of one Kg feed, whereas those containing different levels of PHM showed lower price for each one Kg feed. Increasing the dietary PHM level decreased almost the price of each one Kg feed.

The diet contained 5 % PHM achieved the lowest feed cost / Kg WG (1.957 LE) followed by the control diet (2.286 LE), while, the highest feed cost / Kg WG (4.501 LE) was shown by the diet contained 15 % PHM.

In all cases, diets achieved the lowest feed cost / Kg WG values, recorded almost the best economic efficiency values. Thus, the diet containing 5% PHM showed the best economic feed

Table (60): Effect of feeding different dietary levels of PHM on the economic efficiency of experimental diets.

Items	Control	5% PHM	10% PHM	15% PHM	20% PHM
(A) Price/kg feed, LE.	1.138	1.115	1.004	1.012	1.006
Average FI / chick, kg.	4.065	3.507	3.307	2.250	3.296
Total feed cost / chick, LE	4.63	3.910	3.450	3.290	3.320
Average WG /chick, kg	2.025	1.998	1.195	0.731	0.764
(B) Price/kg LBW, (LE)	700	7.000	7.000	7.000	7.000
Total revenue, LE	14.18	13.99	8.370	5.120	5.350
Net revenue/chick, LE	9.55	10.08	4.910	1.830	2.030
Feed cost /Kg WG, LE.	2.286	1.957	2.887	4.501	4.346
Economic efficiency, EEf.	2.063	2.578	1.423	0.556	0.611
(C) Relative EEf.	100	124.92	68.98	26.95	29.62

A - Based on the price of different ingredients available in the market at the experimental period.

B - According to the local market price at the experimental time.

C - Assuming that the relative EEf of the control diet equals 100.

efficiency value followed by the control diet being 2.578 and 2.063, respectively, whereas the diet having 15% PHM recorded the lowest value (0.556).

Assuming that the EEf of the control diet equals 100, the relative EEf values will be 124.92, 68.98, 26.95 and 29.62 for diets with 5, 10, 15 and 20% PHM, indicating that diet with 5% PHM recorded the best value.

In agreement with the previous results, **Ali (1998)** reported that the lowest feed cost / chick was shown by 5 % pea by-product treatment and the highest one was recorded by 10 % pea by-product treatment. Chicks fed 5 % pea by-product recorded the highest total and net revenue values, whereas, those fed 15 % pea by-product dietary level showed the respective lower values. The highest (best) relative economic efficiency values were recorded by chicks of 5 % pea by-product treatment, whereas, the least one was shown by 15 % pea by-product one.

4.3.4. Fourth feeding experiment (date stone meal).

4.3.4.1. Effect of feeding different dietary levels of date stone meal on growth performance of broiler chicks

4.3.4.1.1. Live body weight.

Data in Table (61) showed the effect of DSM levels on average LBW of broiler chicks at different ages of the experimental period.

The average initial LBW of chicks at the start of the experiment (1 week of age) was nearly similar, with no significant differences (Tables 61 and 62).

Table (61): Live body weight (g ± SE) of broiler chicks fed different dietary levels of DSM at different ages of the experimental period.

Treatments	Body weight (g)			
	1 week	3 weeks	7 weeks	8 weeks
Control	140.67± 00.88	490.33± 28.60 [a]	1795.67± 85.49 [a]	2165.33±50.36 [ab]
5% DSM	141.00± 01.15	507.00± 15.87 [a]	1861.67± 10.59 [a]	2365.33± 47.87 [a]
10% DSM	139.67± 00.67	456.00± 30.26 [a]	1462.33± 112.65 [b]	1882.67± 252.25 [b]
15% DSM	141.67± 01.33	367.33± 27.69 [b]	1075.00± 12.86 [c]	1226.00± 55.77 [c]
20% DSM	139.33± 00.33	374.33± 03.18 [b]	700.33± 13.28 [d]	795.33± 12.55 [d]

SE= Standard error

a, b, c and d: means within the same column with different superscripts are significantly (P<0.05) different.

Table (62): Analysis of variance of live body weight (g) of broiler chicks fed different dietary levels at different ages of the experimental period.

Source of variance	df	Mean squares and F values							
		1 week		3 weeks		7 weeks		8 weeks	
		MS	F	MS	F	MS	F	MS	F
Treatments	4	2.77	0.97	12649.50	6.83*	724895.33	81.54***	1301111.07	37.03***
Replicates	2	1.87	0.65	880.20	0.48	25798.20	2.90	74645.07	2.12
Error	8	2.87		1852.20		8890.53		35134.57	

* = (P < 0.05)　　　　*** = (P < 0.001)

At 3 weeks of age, chicks fed 5% DSM achieved the highest LBW followed by those fed the control diet and 10% DSM, being 507.00, 490.33 and 456.00g, respectively, with no significant differences between the three treatments. While, chicks fed the diet with 15% DSM showed the lowest LBW, followed by those fed 20% DSM (367.33 and 374.33 g, respectively), the differences between the two treatments were not significant. However, the differences in LBW between chicks fed 5% DSM, the control diet or 10% DSM and those fed either 15% or 20% DSM were significant ($P<0.05$), Tables (61) and (62).

The average LBW of chicks at 7 weeks of age, showed also that chicks fed 5% DSM recorded the highest LBW followed by those fed the control diet, with no significant differences. Whereas, chicks fed 20% DSM showed the lowest ($P<0.05$) LBW. However, results in Table (61) revealed that LBW decreased significantly ($P<0.05$) with increasing DSM level from 5% to either 10, 15 or 20% DSM.

Values of LBW at 8 weeks of age followed the same trend observed at 7 weeks of age. The highest LBW values were recorded by chicks fed 5% DSM and the control diet, with no significant differences. While, the lowest ($P<0.05$) LBW value was shown by chicks fed 20% DSM. Average LBW of chicks decreased significantly ($P<0.05$) with increasing the dietary DSM level.

4.3.4.1.2. Weight gain.

Averages of WG for chicks as affected by different dietary levels of DSM at different experimental periods are presented in Table (63). Results of the analysis of variance of data obtained are given in Table (64).

Table (63): Weight gain (g ± SE) of broiler chicks fed different dietary levels of DSM at different experimental periods.

Treatments	Weight gain (g)			
	1-3 weeks	3-7 weeks	7-8 weeks	1-8 weeks
Control	a 349.67± 27.74	a 1305.33± 110.96	ab 369.67± 73.10	ab 2024.67± 50.17
5% DSM	a 366.00± 15.53	a 1354.67± 12.81	a 503.67± 39.29	a 2224.33± 47.13
10% DSM	a 316.33± 29.78	b 1006.33± 96.18	a 420.33 144.15	b 1743.00±251.59
15% DSM	b 225.67± 28.75	c 707.67± 38.11	bc 151.00± 53.11	c 1084.33± 5696
20% DSM	b 235.00± 03.06	d 326.00± 10.44	c 95.00± 04.73	d 656.00± 12.66

SE= Standard error

a, b, c and d: means within the same column with different superscripts are significantly (P<0.05) different.

Table (64): Analysis of variance of weight gain (g) of broiler chicks fed different dietary levels of DSM at different experimental periods.

Source of variance	df	Mean squares and F values							
		1-3 weeks		3-7 weeks		7-8 weeks		1-8 weeks	
		MS	F	MS	F	MS	F	MS	F
Treatments	4	12621.93	6.83*	555593.83	53.15***	93543.73	4.98*	1299976.43	37.10***
Replicates	2	812.47	0.44	28051.80	2.68	16440.07	0.88	74173.07	2.12
Error	8	1847.63		10452.88		18772.98		35036.98	

* = (P < 0.05) *** = (P < 0.001)

Chicks fed 5% DSM, the control diet and 10% DSM at 1-3 weeks of age, recorded the highest WG values (366.00, 349.67 and 316.33 g respectively) with no significant differences, while those fed 15 and 20% DSM achieved the lowest ($P<0.05$) ones, being 225.67 and 235.00 g, respectively.

The highest WG values at 3-7 weeks of age were shown by chicks fed 5% DSM (1354.67g) followed by those fed the control diet (1305.33 g), no significant differences were detected between the two treatments. Values of WG decreased ($P<0.05$) with increasing the dietary DSM level from 5 to 10, 15 or 20%, being 1006.33, 707.67 and 326.00 g, respectively.

At the period of 7-8 weeks of age, WG values followed nearly the same trend noticed at 1-3 weeks of age. Chicks fed 5%, 10% DSM and the control diet showed the highest WG values, being 503.67, 420.33 and 369.67g, respectively, with no significant differences. Whereas those fed 20 and 15% DSM achieved the lowest ones (95.00 and 151.00 g, respectively), the differences between the two treatments were not significant.

Results of WG values during the entire period (1-8 weeks of age) followed the same trend observed at the period of 3-7 weeks of age as chicks fed 5% DSM and the control diet achieved the highest WG values, being 2224.33 and 2024.67g, respectively, with no significant differences. Averages of WG values decreased ($P<0.05$) with increasing DSM level from 5 to 10, 15 or 20% (1743.00, 1084.33 and 656.00g, respectively).

4.3.4.1.3. Feed intake.

Results of average FI throughout the different experimental periods are shown in Table (65). Analysis of variance for FI values is presented in Table (66).

Table (65): Feed intake (g ± SE) of broiler chicks fed different dietary levels of DSM at different experimental periods.

Treatments	Feed intake (g)			
	1-3 weeks	3-7 weeks	7-8 weeks	1-8 weeks
Control	a 643.67± 39.84	a 2608.67± 135.22	b 812.67± 70.89	a 4065.00± 158.04
5% DSM	a 657.00± 14.19	a 2733.00± 103.58	a 1042.00± 35.79	a 4432.00± 60.70
10% DSM	ab 630.33± 39.50	a 2666.33± 175.27	b 815.00± 67.34	a 4111.67± 266.80
15% DSM	ab 589.33± 34.91	b 2154.33± 131.07	c 655.33± 10.09	b 3399.00± 164.98
20% DSM	b 542.00± 05.29	c 1506.67± 46.56	c 569.33± 11.29	c 2618.00± 32.08

SE= Standard error

a, b and c: means within the same column with different superscripts are significantly (P<0.05) different.

Table (66): Analysis of variance of feed intake (g) of broiler chicks fed different dietary levels of DSM at different experimental periods.

Source of variance	df	Mean squares and F values							
		1-3 weeks		3-7 weeks		7-8 weeks		1-8 weeks	
		MS	F	MS	F	MS	F	MS	F
Treatments	4	6582.43	2.81*	796386.43	16.49***	98138.93	22.03***	1572513.77	23.25***
Replicates	2	4419.27	1.89	44022.20	0.91	15393.87	3.46	113793.87	1.68
Error	8	2341.93		48306.03		4454.03		67621.37	

* = (P < 0.05) *** = (P < 0.001)

The average FI during the period of 1-3 weeks of age ranged from 542.00g for chicks fed 20% DSM to 657.00g for those fed 5% DSM. However, no significant differences were detected in FI values consumed by chicks fed 5% DSM and those fed either the control diet or 10% and 15% DSM. Also, the differences in FI between chicks fed 20% DSM and those fed 10% or 15% DSM were not significant.

Feed intake from 3-7 weeks of age showed that chicks fed 5%, 10% DSM and the control diet consumed the highest amounts of FI, being 2733.00, 2666.33 and 2608.67g, respectively, with no significant differences. Whereas, chicks of 20% DSM treatment recorded the lowest ($P<0.05$) FI value (1506.67g), followed by those fed 15% DSM (2154.33g).

At 7-8 weeks of age, the highest FI ($P<0.05$) was recorded by chicks fed 5% DSM (1042.00g). Whereas, FI values of chicks fed 10% DSM and the control diet were nearly similar being 815.00 and 812.67g, respectively. The lowest FI values ($P<0.05$) were recorded by chicks fed 15 and 20% DSM (655.33 and 569.33 g, respectively).

Average FI during the whole experimental period (1-8 weeks of age) followed nearly the same trend observed at 3-7 weeks of age. The highest amounts of FI were recoded by chicks fed 5, 10% DSM and the control diet (4432.00, 4111.67 and 4065.00g, respectively), while the lowest ($P<0.05$) one was shown by chicks fed 20% DSM (2618.00g), followed by those fed 15% DSM (3399.00g).

4.3.4.1.4. Feed conversion.

The average FC values of the different treatments during the different experimental periods are presented in Table (67), and the statistical analysis for values obtained are shown in Table (68).

The lowest (best) FC values during the period of 1-3 weeks of age were recorded by chicks fed 5% DSM and the control diet being 1.80 and 1.84, respectively. While, the highest (poorest) value (2.72) was for chicks fed 15% DSM. The differences in FC values of chicks fed 5% DSM, the control diet, 10 and 20% DSM were not significant. Also, no significant differences were detected between FC values of chicks fed 10, 15 and 20% DSM.

Results of the period of 3-7 weeks of age revealed that chicks fed the control diet and 5% DSM achieved the best ($P<0.05$) FC values (2.01 and 2.02, respectively), while those on 20% DSM showed the poorest ($P<0.05$) one (4.64). However, no significant differences in FC values were observed between chicks fed 15 and 10% DSM.

At 7-8 weeks of age, the best FC values were recorded by chicks fed 5, 10% DSM and the control diet being 2.08, 2.36 and2.49, respectively, with no significant differences. While, those fed 20 and 15%DSM showed the poorest ($P<0.05$) FC values (6.02 and 5.44, respectively).

Feed conversion values for the entire period (1-8 weeks of age) indicated that chicks fed 5% DSM and the control diet achieved the best ($P<0.05$) FC values being 2.00 and 2.01, respectively, whereas those fed 20% DSM recorded the poorest ($P<0.05$) one (4.00). However, increasing dietary DSM level from 5 to either 10, 15 or 20% significantly ($P<0.05$) increased FC values.

Table (67): Feed conversion (g feed/g gain ± SE) of broiler chicks fed different dietary levels of DSM at different experimental periods.

Treatments	Feed conversion			
	1-3 weeks	3-7 weeks	7-8 weeks	1-8 weeks
Control	a 1.84± 00.03	a 2.01± 00.07	a 2.49± 00.74	a 2.01± 00.07
5% DSM	a 1.80± 00.04	a 2.02± 00.07	a 2.08± 00.09	a 2.00± 00.07
10% DSM	ab 2.00± 00.07	b 2.66± 00.08	a 2.36± 00.70	b 2.41± 00.19
15% DSM	b 2.72± 00.48	b 3.07± 00.28	b 5.44± 01.62	c 3.14± 00.02
20% DSM	ab 2.31± 00.01	c 4.64± 00.29	b 6.02± 00.33	d 4.00± 00.12

SE= Standard error

a, b, c and d: means within the same column with different superscripts are significantly (P<0.05) different.

Table (68): Analysis of variance of feed conversion (g feed/g gain) of broiler chicks fed different dietary levels of DSM at different experimental periods.

Source of variance	df	Mean squares and F values							
		1-3 weeks		3-7 weeks		7-8 weeks		1-8 weeks	
		MS	F	MS	F	MS	F	MS	F
Treatments	4	0.44	2.85*	3.51	40.21***	10.71	4.02*	2.20	81.17***
Replicates	2	0.10	0.65	0.20	2.33	0.72	0.27	0.07	2.68
Error	8	0.16		0.09		2.66		0.03	

* = (P < 0.05)   *** = (P < 0.001)

In general, results of the present study showed that chicks fed 5% DSM and the control diet recorded the highest LBW values at different ages of the experimental period and increasing the dietary DSM level decreased LBW values, almost significantly. Averages of WG during the different experimental periods showed the same trend observed with LBW as averages of WG decreased, mostly significant as dietary DSM level increased. Chicks fed 5% DSM and the control diet recorded the highest WG values, whereas those fed 20% DSM showed the lowest one. Generally, the present results are in harmony with the findings of **Afifi *et al.* (1966)** who found that diets contained up to 10% DSM had no negative effects on body weight of chicks. **Kamel *et al.* (1981)** reported that 5 and 10% dietary pits had a significant effect on growth of broiler chicks. Moreover, **Abdul-Rahman *et al.* (1992)** found that feeding broiler chicks with date by-products (5, 10 or 50%) for the first 14 or 20 days of life had no negative effects on chick performance. **Abdel-Megeed (1993)** concluded that adding 5 or 10% date seeds to starter diets of broiler chicks increased LBW significantly. He added that supplementing finisher ration with date seeds (5/10, 5/15 and 10/15) improved average body WG significantly and that may be due to the fact that the digestive tract will be more response to digest nutrients by advancing age. **Barreveld (1993)** reported that DSM could successfully replace 10% barley content in chick rations. **Vandepopuliere *et al.* (1995)** found that date pits at levels of 5, 10 and 15% in broiler starting diets resulted in growth rate similar to that of the control. **Hammad (1996)** showed that the addition of date stones by levels of 10, 15 and 20% in starter broiler diets improved growth. **El-Bogdady (1995)** indicated that DSM could be used in quail diets at a level of 5% without detrimental effect on the performance.

Feed intake decreased with increasing the level of DSM in the diet during all experimental periods. The highest amounts of FI were recorded by chicks fed 5% DSM followed by those fed 10% DSM and the control diet and the differences were not significant in most cases, Whereas, chicks fed 20% DSM consumed the lowest amount of FI. Increasing the dietary level of DSM had detrimental effect on FC values of broiler chicks during all experimental periods. The best FC values were recorded by chicks fed 5% DSM followed by those fed the control diet, with no significant differences. Whereas, the poorest values were achieved almost by chicks fed 20% DSM. In accordance with the previous results, **Hammad (1996)** revealed that average amounts of FI for broiler chicks were decreased, while body WG and efficiency values were increased with increasing dietary date stone levels from 10 to 15 and 20% during the starting period (1-5 weeks of age) compared with the control. Whereas, **Soliman (1996)** indicated that during the growing period of broiler chicks, body weight and body weight gain were gradually decreased, feed consumption increased and feed conversion was influenced when level of DSM exceeded 5% ($P<0.05$), while at the finishing period there were insignificant differences among all treatment groups fed 5, 10 and 15% DSM in body weight gain, feed consumption and feed conversion values. **Kamel *et al.* (1981)** found that feed efficiency values were not much affected by incorporation of date pits (5, 10 or 15%) in broiler diets**. Gualtieri and Rapaccini (1990)** found that the differences in FI between broiler chicks fed

0% or 10% date stone were not significant**. Abdel-Megeed (1993)** reported that FI for the group of broiler chicks fed 5% date seeds was significantly higher compared with the control or the group fed 15% date stone. There were no significant differences in FC values due to date stone level effects during the starting period. **Vandepopulier *et al* (1995)** using 5, 10 or 15% date pits in broiler starting diets, found that FC was improved comparable to/or better than the control diet.

4.3.4.2. Effect of feeding different dietary levels of date stone meal on nutrients digestibility of broiler chicks.

Results for digestibility of finisher diets for broiler chicks fed different dietary levels of DSM at 8 weeks of age are presented in Table (69) and analysis of variance for these results are shown in Table (70).

The present results showed that broiler chicks fed the control diet recorded the highest DM, OM, CP and NFE digestibility values, while those fed 5% DSM achieved the highest ($P< 0.05$) EE and CF ones. Whereas, chicks fed 20 % DSM showed the lowest DM, OM, CP and CF digestibilities and those fed 15% DSM recorded the lowest EE and NFE ones.

The differences in nutrients digestibility due to treatment effect were significant (Table 70). Increasing the dietary DSM level from 5% to 10, 15 or 20 % almost decreased digestibility values significantly.

Table (69): Effect of feeding different dietary levels of DSM on nutrients digestibility (%) of broiler chicks at 8 weeks of age.

Items	Control	5% DSM	10% DSM	15% DSM	20% DSM
DM	84.48± 0.87 [a]	83.44± 0.60 [a]	80.67± 1.29 [b]	75.58± 0.60 [c]	73.72± 2.34 [c]
OM	86.05± 0.74 [a]	85.58± 0.44 [a]	82.95± 0.94 [b]	78.72± 0.48 [c]	77.19± 1.97 [c]
CP	92.07± 0.70 [a]	90.61± 1.62 [b]	89.78± 0.22 [b]	87.02± 0.85 [c]	84.04± 0.83 [d]
EE	92.88± 0.36 [b]	93.91± 0.52 [a]	92.57± 0.89 [bc]	91.33± 0.15 [d]	91.82± 0.25 [cd]
CF	54.49± 0.34 [b]	58.39± 0.59 [a]	46.93± 2.87 [c]	34.23± 0.79 [d]	29.12± 2.33 [e]
NFE	91.92± 1.66 [a]	91.28± 0.37 [ab]	91.79± 0.56 [a]	89.51± 0.14 [b]	91.46± 1.25 [a]

a,b,c,d and e : means within the same row with different superscripts are significantly ($P < 0.05$) different.

Concerning the digestibility of DSM, **El-Bogdady (1995)** reported that the use of DSM in poultry diets has not very much encouraged and this may be due to its high fiber content which reduces digestibility and availability of nutrients. However, no significant differences were detected in digestibility coefficients due to feeding quail chicks a diet with 15% DSM replaced yellow corn of the control diet (**El-Nagmy *et al*. 2001**).

Ogbonna *et al.* (1988) found that the digestibility of DM was 74.3, 71.5 and 60.6% for diets containing 10, 20 and 40 % palm kernel meal, indicating that DM digestibility decreased with increasing dietary palm kernel meal level. However, **Hammad (1996)** found that the average digestibility values of germinant, fine and crumble date stones determined by the indirect method ranged from 46.89 to 54.93 % for CP, 80.65 to 87.39% for EE, 3.45 to 10.67% for CF, 65.57 to 67.21% for NFE, 61.16 to 63.01% for OM and 57.04 to 59.54% for DM.

4.3.4.3. Effect feeding different dietary levels of date stone meal on carcass characteristics and carcass cuts of broiler chicks.

Results for carcass traits of broiler chicks at 8 weeks of age as affected by different dietary levels of DSM are shown in Table (71). Statistical analysis for results obtained are presented in Table (72).

Results in Table (71) declared that the highest carcass and edible parts percentages were shown by chicks fed 10% dietary DSM followed by those fed 5% dietary DSM, while those fed 20%

dietary DSM recorded the lowest ones. Chicks fed 20 % dietary DSM had the highest blood, feather, inedible parts, heart, giblets and non carcass fat percentages and those fed 5 % dietary DSM achieved the lowest blood, feather, heart and giblets percentages. The lowest inedible parts and non carcass fat percentages were shown by chicks fed 10% and 15 % dietary DSM, respectively. The highest liver, gizzard and empty intestines percentages were recorded by broilers fed the control diet and 15% dietary DSM, respectively, whereas, the lowest ones were achieved by those fed 15% dietary DSM, control diet and 5 % dietary DSM, respectively.

Data in Table (72) indicated that all carcass characteristics percentages were significantly affected by dietary treatments except the liver and empty intestines percentages.

Results of carcass cuts (Table 73) showed that chicks fed the diet with 5% DSM recorded the highest hind legs, drumstick, breast, total meat, breast meat and hind legs meat percentages. The highest thigh, total bone and total fat percentages were shown by chicks fed the diet of 20% DSM and the highest wings percentages were achieved by chicks fed 10% DSM.

The lowest hind legs, thigh, breast and breast meat percentages were shown by chicks fed 15% DSM and the lowest drumstick, total meat, and hind legs meat percentages were achieved by chicks fed 20% DSM. Chicks fed 5% DSM had the lowest wings and total bone percentages and those fed 10% DSM showed the lowest total fat one.

The differences in all carcass cuts percentages due to DSM level effect were significant except for hind legs, thigh and wings percentages (Table 74).

Regarding the effect of date stone on carcass characteristics, **Sharaf (1968)** reported that dietary date stone improved weight of body and organs (heart, liver, kidney, spleen and ovary) in rabbits and chickens. **Abdel-Megeed (1993)** reported that the differences in carcass weight of broilers due to date seed levels (5, 10 and 15%) effect were significant. Differences between 5% fed group and the control group were significant. But differences among 5% fed group and other groups were non-significant. Percentage of carcass weight of the control group was higher than that of other groups except 5/10 groups. However, giblets weight or percentage were not significantly affected by date seeds level.

On the contrary **Hammad (1996)** reported that edible parts, carcass weight and hind parts weight for broilers fed different levels of date stones (10, 15 and 20 %) were lower than those of the control, while front part was not significantly different from that of the control group. The weight of gizzard and digestive tract increased with increasing of date stone level. Heart weight for broilers fed date stone levels were higher than that of the control group. Similarly, **Onwudike (1986 b)** found that abdominal fat significantly ($P<0.05$) decreased as level of palm kernel meal fed increased, while the gizzard weight significantly ($P<0.05$) increased.

However, **Kamel *et al.* (1981)** concluded that gross observation of various organs (liver, heart, spleen, pancreas and intestines) from chicks fed the various date pits levels (5, 10 and 15%) did not reveal any abnormalities. The various organ weight as a percent of body weight were of the same magnitude and not significantly affected by level of inclusion of date pits in the diet, but gizzard percentage ($P<0.05$), small intestine length and caecum length ($P<0.05$) were significantly increased with increasing level of dietary date pits. **Onwudike (1986 b)** obtained similar results with broilers, **El-Bogdady (1995)** with quail and **Osman *et al* (1995)** with duckling. Also **Al-Homidan (2003)** concluded that date pits meal at levels of 5, 10 or 15% had no effects on carcass characteristics of broiler chicks at 7 weeks of age.

4.3.4.4. Effect of feeding different dietary levels of date stone meal on chemical composition of broiler chicks meat.

Data of chemical composition of broiler chicks meat at 8 weeks of age as affected by different dietary levels of DSM are illustrated in Table (75). Analysis of variance (Table 76) showed that the differences in chemical composition of broilers meat due to DSM level effects were significant.

Chicks fed 20% DSM achieved the highest moisture percentage and the lowest DM one, whereas those fed 5 % DSM recorded the highest DM and ash contents and the lowest moisture percentage.

The highest CP and lowest EE percentages were shown by chicks fed 20% DSM, whereas the highest EE content and lowest CP and ash ones were achieved by broilers fed the control diet.

Table (75): Effect of feeding different dietary levels of DSM on chemical composition (%) of broiler meat.

Items	Control	5% DSM	10% DSM	15% DSM	20% DSM
Moisture	71.29±3.48 [b]	71.27±2.49 [b]	71.85 0.27 [b]	73.43±0.17 [ab]	74.88±0.10 [a]
DM	28.71±8.64 [a]	28.73±6.18 [a]	28.15±0.27 [a]	26.57±0.17 [ab]	25.12±0.10 [b]
CP	71.41±0.36 [c]	73.44± 0.56 [b]	73.88±00.23 [b]	76.42±0.78 [a]	79.03±0.05 [a]
EE	24.73±0.32 [a]	21.84±0.73 [b]	21.55±0.14 [b]	19.57±1.02 [c]	16.39±0.73 [d]
Ash	3.86±1.29 [c]	4.72±4.24 [a]	4.57±4.37 [a]	4.01±0.50 [b]	4.58±4.37 [a]

a, b, c, and d : means within each row with different superscripts are significantly (P<0.05) different.

Table (76): Analysis of variance for the effect of feeding different dietary levels of DSM on chemical composition (%) of broiler chicks meat.

Source of variance	df	Mean squares and F values									
		Moisture		DM		CP		EE		Ash	
		MS	F	MS	F	MS	F	MS	F	MS	F
Treatments	4	7.44	4.07*	7.44	4.07*	26.02	183.31***	28.54	811.16***	0.45	15.19***
Replicates	2	2.33	1.27	2.33	1.27	0.06	0.41	0.01	0.23	0.01	0.19
Error	8	1.83		1.83		0.14		0.04		0.03	

* = (P < 0.05)   *** = (P < 0.001)

4.3.4.5. Effect of feeding different dietary levels of date stone meal on the economic efficiency of experimental diets.

The effect of using different dietary levels of DSM on the economic efficiency of the experimental diets is illustrated in Table (77). Data obtained revealed that the diet contained 5% DSM recorded the highest price of one Kg feed followed by that with 10 % DSM and the control diet, while those contained 20% and 15% DSM showed the lowest price for one Kg feed. Increasing the dietary DSM level decreased the price of one Kg feed.

The lowest feed cost / Kg WG was shown by the control diet followed by the diet having 5 % DSM, whereas, the highest one was achieved by the diet containing 20 % DSM.

The diets recorded the lowest feed cost / Kg WG values, showed almost the best economic efficiency values. Therefore, the control diet recorded the best economic efficiency value (2.063) followed by that contained 5% DSM, whereas, the diet contained 20% DSM achieved the lowest (poorest) economic efficiency value.

Considering the relative economic efficiency of the control diet equals 100, values of other diets were 90.01, 71.74, 51.24 and 36.79 for diets contained 5, 10, 15 and 20 % DSM, respectively.

On the contrary with the previous results, **Abdel-Megeed (1993)** found that the price / Kg for starter diets contained 10% date seeds and finisher diets with 15% date seeds were cheaper than that

Table (77): Effect of feeding different dietary levels of DSM on the economic efficiency of experimental diets.

Items	Control	5 % DSM	10% DSM	15% DSM	20% DSM
(A) Price/kg feed, LE.	1.138	1.229	1.196	1.085	0.997
Average FI/chick, kg.	4.065	4.432	4.111	3.399	2.618
Total feed cost, LE.	4.63	5.45	4.92	3.69	2.61
Average WG/chick, kg.	2.025	2.224	1.743	1.084	0.656
(B) Price/kg LBW, LE.	7.00	7.00	7.00	7.00	7.00
Total revenue, LE.	14.18	15.57	12.20	7.59	4.59
Net revenue/chick, LE.	9.55	10.12	7.28	3.90	1.98
Feed cost / Kg WG, LE.	2.286	2.451	2.823	3.404	3.979
Economic efficiency, EEf .	2.063	1.857	1.480	1.057	0.759
(C) Relative EEf.	100	90.01	71.74	51.24	36.79

A - Based on the price of different ingredients available in the market at the experimental period.
B - According to the local market price at the experimental time.
C - Assuming that the relative EEf of the control diet equals 100.

of the control one. The addition of date seeds to broiler diets increased the profit compared with the control. Similarly, **Hammad (1996)** reported that feed cost/Kg body gain of broilers fed different levels of date stones (10, 15 and 20 %) were lower than that of the control group during the starting and whole periods, while it was almost higher than that of the control during the finishing period. Economic efficiency of all experimental groups were higher with about 16 to 71% more than the control. Also, **Onwudike (1986 b)** reported that the cost of feed decreased as the dietary palm kernel meal level increased.

El-Nagmy *et al.* (2001) indicated that feeding quails 15 % dietary DSM instead of yellow corn increased relative economical efficiency compared with groups fed the yellow corn control group. Moreover, **Al-Homidan (2003)** recommended that date pits meal could be included at 15 % in broiler diets to support and enhance economical efficiency without adverse effect on productive performance or carcass traits of broiler until 7 weeks of age under intensive production management.