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CHEMICAL AND BIOLOGICAL EVALUATION OF JOJOBA SEEEDS AND JOJOBA MEAL *(Simmondsia chinensis)* IN COMPARISON WITH SOME OTHER PLANT PROTEIN SOURCES.

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ABSTRACT

Chemical and biological studies were carried out to compare three samples of jojoba with soybean meal (SBM), sunflower meal (SFM) and rapeseed meal (RSM) as plant protein sources. The jojoba samples were jojoba seed (JS), extracted crushed jojoba seed meal (JM_1) and extracted whole seed jojoba meal (JM_2). Chemical evaluation, metabolizable energy assays, protein digestibility and amino acids pattern and availability were studied. The results of protein content of JS, JM_1, JM_2, SBM, SFM and RSM were 14.18, 24.95, 31.29, 47.74, 38.39 and 35.22, respectively. Among the ten essential amino acids assayed, the 1st limiting amino acid (LAA) in JM_1 and JM_2 was methionine and the 2nd was lysine. Chemical score and essential amino acid index (EAAI) for all tested materials were estimated. The AME values (Kcal/g DM) were 4.095, 3.153, 3.110, 2.494, 2.428 and 2.312 for JS, JM_1, JM_2, SBM, SFM and RSM, respectively. Coefficients of metabolized GE as well as some relationships among four estimates of metabolized GE as well as some relationships among four estimates of bioavailable energy were discussed.

The mean values of Apparent amino acid availability (AAAA) were 67.42%, 71.99%, 76.49%, 82.58%, 84.50% and 75.37% for JS, JM_1, JM_2, SBM, SFM and RSM, respectively. The mean values of True amino acid availability (TAAA) were 86.29%, 83.62%, 85.82%, 88.01%, 92.28% and 83.77% at the same order, respectively. The apparent protein digestibility (APD) and true protein digestibility (TPD) for JM_1 and JM_2 recorded higher values than for JS, however, the values were nearly close to those obtained with some other tested materials. The most important aspect that should be taken into consideration in future work is the toxic compounds found in jojoba meal. Jojoba meal should be detoxified to be accepted as an ingredient in poultry feed. It should be noted that no toxic effects appeared in the present work because the birds were fed small amount of feed (35g) for one time only. In conclusion, the jojoba meal, as a by-product of jojoba seeds, is a promising feedstuff after being detoxified.

Keywords: Chemical evaluation, biological evaluation, jojoba meal, plant protein sources, poultry nutrition.

INTRODUCTION

The jojoba plant *(Simmondisa chinensis)* is a native oilseed shrub in the semiarid regions of Southern Arizona and California and Northwest Mexico.

Jojoba seed contains about 50% oil and light-gold colored ester liquid wax. Jojoba wax (called oil) is characterized with high viscosity, high flush and fire point, high stability, low volatility and is not affected by temperature up to 300L. It is composed of straight chain C_{20} and C_{22} fatty acids and alcohol and 2 unsaturated bonds. The average carbon chain length is 42 carbons. (Undersander *et al.*, 1990).

The oil is not toxic and resistant to rancidity (Benzioni, 1997). The jojoba oil does not contain cholesterol or triglycerides and is not broken down by normal metabolic pathways. It is used mainly in cosmotic, hair products, high pressure lubricant, in computers and electronic industries, (Undersander *et al.*, 1990).

On extracting by using screw pressing, the oil of jojoba plant is removed and the residue being jojoba meal contains 26-30% crude protein as reported by Verbiscar and Banigan (1978), and Wisniak (1987). The meal contains a group of glycosides, known as food intake inhibitors containing simmondsin, being the most toxic factor. (Benzioni, 1997).

The Egyptian Natural oil company introduced jojoba plant in Egypt. It has been planted in areas near Ismailia with crop promising production. As the plant requirements for water in volume and quality is very moderate, it is expected that it will be propagated in the Egyptian deserts.

The present work is planned to start a research project on the jojoba meal in respect to its use as an ingredient in poultry feeds. The first piece of work will handle the nutritional value of the raw meal.

MATERIALS AND METHODS

The present work was carried out at the Central Laboratory for Food and Feed (CLFF), Agricultural Research Centre of the Ministry of Agriculture, Egypt.

Materials:

Three samples of jojoba were used, one sample of jojoba seed (JS) and two different samples of jojoba meals (JM_1 and JM_2). Oil had been extracted by press extraction process. Sample JM_1 was crushed before extraction and sample JM_2 was extracted as intact seed. Samples obtained were cultivated by Egyptian Natural Oil Company. The samples of jojoba were compared with three samples of other plant protein sources, being soybean meal (SBM), sunflower meal (SFM) and rapeseed meal (RSM). Representative samples were taken for analysis.

Methods:

I. Proximate composition

All samples were analysed for their proximate composition which was carried out according to A.O.A.C (2000). Triplicate sub-samples were used for each determination. Nitrogen free extract (NFE) was calculated by difference.

II. Metabolizable Energy (ME)

The ME assay was carried out according to the TME system described by Sibbald (1976) and developed by Sibbald (1986). A number of 20 adult cockerels of nearly similar body weight were allocated individually in metabolism cages providing facilities to collect excreta free from feathers and feed. Feed and water were provided *ad libitum*. Five birds were individually used for each test material. Birds were fasted for 24hr to empty their digestive tract and then force-fed 35g test material. Five birds were kept starving for the determination of the endogenous losses. Excreta were collected after 48hr, free from any feathers, dried at 60°C, equilibrated with atmospheric moisture, weighed, ground and kept for analysis. Gross energy value of the test materials and the excreta were determined using an adiabatic oxygen bomb calorimeter. The energy values (AME, AME_n, TME and TME_n) were calculated as described by Mohamed *et al.* (1988).

True metabolizable energy corrected to zero nitrogen balance (TME_n) was calculated as follows (Parsons *et al.*, 1982 and Sibbald, 1986).

$$TME_n \text{ (Kcal/g dry matter)} = \frac{FE_f - [\,EE_f + 8.22\ N_f\,] + [\,EE_u + 8.22\ N_u\,]}{F}$$

Where:

FE_f : The gross energy of the total feed consumed
EE_f : The gross energy of the excreta collected from the fed bird.
EE_u : The gross energy of the excreta collected from unfed bird.
N_f : g nitrogen retained by the fed bird.
N_u : g nitrogen retained by the unfed bird.
F : g of feed intake.
8.22 : The energy in Kcal/g N retained or lost by the bird.

The classical metabolizable energy (AME) and its correction to zero nitrogen balance (AME_n) could be calculated as followas Sibbald (1986).

$$AME_n = \frac{FE_f - [EEf + 8.22\ N_f]}{F}$$

Where:

FE_f : The gross energy of the total feed consumed
EE_f : The gross energy of the excreta collected from the fed bird.
N_f : g nitrogen retained by the fed bird.
F : g of feed intake.
8.22 : The energy in Kcal/g N retained or lost by the bird.

$$\text{Coefficient of metabolized GE} = \frac{\text{ME value}}{\text{Its GE value}} \times 100$$

III. Proteins and amino acids

a. Proteins

Protein digestibility values were determined using sub-samples of the excreta collected from the TME assays. The method of Terpstra and Dehart *(1974)* was used for distinguishing between urinary nitrogen and faecal nitrogen. In this method, uric acid was hold in solution by formaldehyde then faecal nitrogen was precipitated using lead acetate.

From the faecal nitrogen, the apparent digestibility of the feed protein was calculated. Apparent protein digestibility (APD) was calculated as follows:

$$APD = \frac{\text{(g) Nitrogen intake} - \text{(g) faecal nitrogen excreted}}{\text{(g) Nitrogen intake}} \times 100$$

When the protein excreted from the starved birds is considered, the true protein digestibility (TPD) could be calculated as follows (Mohamed *et al.*, 1991)

$$TPD = \frac{\text{(g) Nitrogen intake} - \left[\text{g Nitrogen excreted from fed bird} - \text{g Nitrogen excreted from unfed bird}\right]}{\text{(g) Nitrogen intake}} \times 100$$

b.Amino acids

Amino acids composition, except for tryptophan and tyrosine, of the test materials and excreta were determined according to the method of the Official Journal of the European Communities, (19-9-98). High performance amino acid Analyzer, Beckman, 7300 was used.

Apparent and true amino acid availability (AAAA and TAAA), values were calculated as described by El-Sherbiny *et al.* (1988) and Mohamed *et al.* (1991).

$$AAAA = \frac{AA_I - AA_f}{AA_I} \times 100$$

$$TAAA = \frac{AA_I - (AA_f - AA_u)}{AA_I} \times 100$$

Where:

AA_I : Total amount of AA consumed by the fed bird.

AA_f : Total amount of AA voided in excreta of the fed bird during 48 hour collection period.

AA_u : Total amount of AA voided in excreta by the unfed bird during 48hour collection period.

RESULTS

I. Proximate composition

From Table (1), it is apparent that irrespective of JS, the crude protein (N x 6.25) content of JM_1 and JM_2 are the lowest compared to those of SBM, SFM and RSM samples. It is also noted that EE for both JM_1 and JM_2 are the highest compared to the other meals. The ash content on the other hand showed the lower values for JM_1 and JM_2 than the other meals.

Crude fiber content of the J.S. is the lowest, while that for JM_1 showed the highest.

II. Metabolizable Energy

Table (2) presents the gross energy (GE), apparent metabolizable energy (AME), AME adjusted to zero nitrogen retained (AME_n), true metabolizable energy TME and TME adjusted to zero nitrogen retained (TME_n).

Table (1): Proximate composition (%) of JS, JM_1, JM_2, SBM, SFM and RSM (on DM basis).

Feed	DM	CP	EE	CF	ASH	NFE
JS	95.20	14.18	31.39	4.75	2.00	47.68
JM1	92.40	24.95	18.33	21.00	3.47	32.25
JM2	93.00	31.29	11.01	15.67	3.94	38.09
SBM	90.70	47.74	0.78	7.19	6.22	38.07
SFM	92.20	38.39	1.02	19.77	7.17	33.65
RSM	93.69	35.22	8.11	12.50	7.47	36.70

Table (2): Metabolizable energy values (Kcal/g DM) and coefficients of gross energy metabolized for JS, JM_1, JM_2, SBM, SFM and RSM.

Feed	GE	AME	AME_n	TME	TME_n	Coefficients of metabolized GE			
						AME	AME_n	TME	TME_n
JS	5.760	4.095	3.825	4.264	4.106	71.09	66.41	74.03	71.28
JM_1	4.632	3.153	2.866	3.305	3.170	68.07	61.87	71.35	68.44
JM_2	4.328	3.110	2.733	3.172	3.060	71.86	63.15	73.29	70.70
SBM	4.450	2.494	2.291	2.866	2.640	56.04	51.48	64.40	59.33
SFM	4.298	2.428	2.409	2.846	2.490	56.99	56.05	66.22	57.93
RSM	4.543	2.312	2.235	2.562	2.396	50.89	49.20	56.39	52.74

The GE value of jojoba seed recorded the highest value 5.760 Kcal/g DM mainly due to its high fat content. The GE value of the tested RSM was within the range of 3.819 to 5.043 Kcal/g DM given by Bell and Keith (1991) on examining several samples of RSM of different cultivars. The GE of tested SBM recorded 4.450 Kcal/g DM, was almost similar to the GE found by (Mohamed *et al.,* 1988). Variations in GE content of JM_1 and JM_2 could be attributed to their composition, especially the ether extract content. Not all the gross energy content of a feedstuff is available to the bird. The bioavailability of energy was measured as metabolizable energy which is considered to be the reliable value in evaluating poultry feeds.

The AME_n of JM_1 2.866 Kcal/g DM was slightly higher than the corresponding value of JM_2 2.733Kcal/g DM and both these values were higher than SBM, SFM and RSM. The same sequence was obtained for AME values being 3.153, 3.110, 2.494, 2.428 and 2.312 Kcal/g DM for JM_1, JM_2, SBM, SFM and RSM, respectively. It should be noted that the AME values at zero nitrogen retention (AME_n) were lower than their corresponding values of AME. The TME of JM_1 3.305 Kcal/g DM was slightly higher than the JM_2 being 3.172 Kcal/g DM and both values were higher than the other tested meals that recorded 2.866, 2.846, and 2.562 Kcal/g DM for SBM, SFM and RSM, respectively. The J.S recorded the highest TME value being 4.264 Kcal/g DM. It is clear that the true metabolizable energy values corrected to zero nitrogen retention (TME_n) were also lower than their corresponding uncorrected values (TME). The reduction was mainly due to the large nitrogen losses by fasted birds compared to fed birds (Parsons *et al.*, 1982). The TME_n value of JM_1 3.170 Kcal/g DM was slightly higher than the JM_2 3.060 Kcal/g DM and both values were higher than the other tested meals that recorded 2.640, 2.490 and 2.396 for SBM, SFM and RSM, respectively.

The coefficients of GE metabolized values nearly followed the same trend as those for ME values being the highest for TME which ranged from 56.39 for RSM to 74.03% for JS. The lowest values were recorded for AME being ranged from 50.89 for RSM to 71.09% for jojoba seed.

Relationships among the four estimates of bioavailable energy are presented in Table (3).

Table (3): Relationships among the four estimates of bioavailable energy.

Ingredient	TME/AME	TME/AME_n	TME_n/AME_n
J.S	1.041	1.115	1.073
JM_1	1.048	1.153	1.106
JM_2	1.019	1.161	1.120
SBM	1.149	1.251	1.152
SFM	1.172	1.181	1.034
RSM	1.108	1.146	1.072
Mean value	1.090	1.168	1.093

The data presented in Table (3) led to the conclusion that TME requirement of a bird equals 1.090 times of its AME requirement or 1.168 times of its AME_n requirement while TME_n requirement equals 1.093 AME_n requirements. The derived ratio of TME/AME_n (1.168) in the present study was higher than those obtained by Sibbald (1982) for alfalfa meals and corn (1.016) and the ratio obtained by Yamazaki (1987) which averaged in 1.13 (ranging from 0.964 for sesame seed meal to 1.059 for rapeseed meal), but nearly close to those obtained by Halloran (1980) for corn (1.16), Mohamed *et al.* (1988) for poultry by product, fish meal, hydrolyzed feather meal and soybean meal (1.17). In the present study, TME_n/AME_n average ratio was (1.093) (ranging from of (1.034 to 1.152) being higher than that reported by Yamazaki (1987) which ranged from 0.954 to 1.22 with an average of 1.06.

From the present study, a conversion factor obtained by mathematical and statistical evaluation could only be an approximation. This system of arriving at a set of TME requirement will make it possible for feed formulators to adopt to TME system of energy measurements.

III. Proteins and amino acids

a. Proteins:

Table (4) shows the apparent protein digestibility (APD) and true protein digestibility (TPD) values of the JS and both JM_1 and JM_2 in comparison with the other plant protein sources in the present study.

Table (4): Apparent (APD) and true (TPD) protein digestibility (%) of JS, JM_1, JM_2, SBM, SFM and RSM.

Sample	APD	TPD
JS	54.71	75.39
JM_1	66.79	78.90
JM_2	74.81	84.40
SBM	85.52	91.98
SFM	78.61	86.50
RSM	78.96	87.42

Table (5) presents the concentration of amino acids determined (calculated as g/16g nitrogen) of the experimental samples.

Table (5): Amino acids composition (g/16gN) of JS, JM_1, JM_2, SBM, SFM and RSM.

Amino acid	JS	JM1	JM2	SBM	SFM	RSM
Aspartic acid	9.59	8.63	9.00	10.82	10.00	5.94
Threonine	4.79	4.73	4.60	4.02	3.62	4.22
Serine	4.37	4.47	4.05	5.09	3.78	4.18
Glutamic acid	10.01	10.89	10.52	11.96	16.83	14.71
Proline	4.02	4.34	4.19	4.88	3.67	5.24
Glycine	8.11	8.50	8.18	4.86	6.56	4.89
Alanine	3.74	3.77	3.64	4.96	4.77	3.91
Valine	5.08	4.38	4.33	5.30	5.47	4.52
Iso-Leucine	3.74	3.04	2.99	4.75	4.06	3.50
Leucine	6.49	6.29	6.29	8.32	6.23	6.81
Phenylalanine	6.84	3.77	3.78	5.30	4.56	3.84
Histidine	3.03	1.78	1.79	3.67	3.44	2.88
Lysine	4.02	4.08	4.02	6.64	3.18	5.24
Arginine	6.42	6.38	6.49	7.23	4.87	5.67
Cystine	2.75	3.47	3.44	1.36	2.14	2.26
Methionine	2.55	1.26	1.17	1.42	2.60	1.78
SAA*	5.30	4.73	4.61	2.78	4.74	4.04

***SAA = Sulfur amino acids**

These results agree with those of Verbiscar and Banigan (1978) for amino acid composition.

The sulfur amino acids content in both jojoba meals (4.73 and 4.61 g/16gN) are comparable to the content of sulfur amino acids concentration in SFM and RSM, being 4.74 and 4.04 g/16gN, respectively. However, jojoba seed and both jojoba meals contain higher sulfur amino acids than SBM (2.78g/16gN). In respect to lysine, SBM contains the highest concentration (6.64), while jojoba seed and jojoba meals content were almost 4.0%, being higher than that recorded for SFM (3.18).

Table (6): Essential amino acid (EAA) composition (g/16gN), chemical score (CS), essential amino acid index (EAAI) and limiting amino acid (LAA) of JS, JM1, JM2, SBM, SFM and RSM.

Amino Acid	JS	JM1	JM2	SBM	SFM	RSM	Chick starter Requirement*	Whole Egg**
Arg	6.42	6.38	6.49	7.23	4.87	5.67	5.43	6.40
His	3.03	1.78	1.79	3.67	3.44	2.88	1.52	2.10
Lys	4.02	4.08	4.02	6.64	3.18	5.24	4.78	7.20
Phy	6.84	3.77	3.78	5.30	4.56	3.84	3.13	6.30
Cys	2.75	3.47	3.44	1.36	2.14	2.26	1.74	2.40
Met	2.55	1.26	1.17	1.42	2.60	1.78	2.17	4.10
Thr	4.79	4.73	4.60	4.02	3.62	4.22	3.48	4.90
Ile	3.74	3.04	2.99	4.75	4.06	3.50	3.48	8.00
Leu	6.49	6.29	6.29	8.32	6.23	6.81	5.22	9.20
Val.	5.08	4.38	4.33	5.30	5.47	4.52	3.90	7.30
CS	85.20	58.06	53.92	65.44	66.50	82.03	100.00	----
EAAI	62.27	67.33	66.48	62.85	57.97	57.28	----	100.00
1st LAA	Lys	Meth	Meth	Meth	Lys	Meth	----	
2nd LAA	----	Lys	Lys	Cys	Arg	----	----	----
3rd LAA	----	Ile	Ile	----	----	----	----	----

*** NRC (1994)** **** Block and Mitchell (1946)**

The amino acids content of jojoba seed and jojoba meals would indicate that the seed protein contained higher amounts of most essential AA than those of the meal protein. This might be due to the effect of processing procedure on the amino acid pattern of the produced meal. The Essential Amino Acids Index (EAAI) was calculated and shown in Table (6). $JM_1$and JM_2 showed the highest EAAI, being 67.33 and 66.48, respectively. SBM gave a value of 62.85, while SFM and RSM gave the lowest values being 57.97 and 57.28, respectively.

The nutritive value of any plant protein source is correlated quite well with the chemical score of the feed calculated from their amino acids content, (Block and Mitchell, 1946). The chemical score calculation was based on the suggested chick requirements of amino acids, (NRC, 1994). The results showed that the chemical score (CS) of JS is the highest compared to other studied samples. Both jojoba meals gave values of 58.06 and 53.92 in contrast with the results showed by EAAI values (67.33 and 66.48). Ngoupayou *et al* (1982) carried out an experiment with chicks and found that the EAAI was 92.9 where Lysine was the first limiting, and leucine being the 2[nd] LAA, however the chemical score was 48.5%. The limiting amino acids (LAA) were arranged for each experimental feedstuff in descending order, i.e. first LAA, second LAA and third LAA, as shown in Table (6). Methionine was the 1[st] LAA over all the experimental feedstuffs with exception to jojoba seed and sunflower meal where lysine was the 1[st] LAA. It was found that lysine and iso-leucine were the 2[nd] and 3[rd] LAA for both jojoba meals. In general, both jojoba meals are deficient in methionine, lysine and iso-leucine.

The results of apparent amino acid availability (AAAA) and true amino acid availability (TAAA) for JS, JM_1, JM_2, SBM, SFM and RSM are shown in Table (7).

It is clear that the values of TAAA are higher than those of AAAA because of the correction for metabolic faecal and endogenous urinary AA excretion. The mean of AAAA and TAAA values of jojoba meals (both JM_1 and JM_2) were 74.24 and 84.72%, respectively. Generally, the means of TAAA values of tested jojoba meals were lower than those of SBM and SFM and the JM_1 corresponding results of RSM. Compared with SBM, the mean apparent and true amino acid availability of JM_1 and JM_2 were markedly lower than the tested SBM values i.e. 82.58 and 91.30% and also lower than the reported values of 86 and 90% for SBM obtained by EL-Sherbiny *et al.,* (1988) using the same technique of Sibbald (1976,1979). This indicates that the amino acid availabilities of JM are lower than those observed for SBM, confirming the superiority of SBM protein quality compared with that of JS. Haready *et al.* (2005) in a trial with guar germ as protein source found that TAAA was 79.3%, while El-Sherbiny *et al* (1994) found that TAAA was 81.4% for RSM.

Table (7) Percentage of Apparent and True amino acid availability of JS, JM, SBM, SFM and RSM.

amino acids	Apparent amino acid availability (AAAA)						True amino acid availability (TAAA)					
	JS	JM1	JM2	SBM	SFM	RSM	JS	JM1	JM2	SBM	SFM	RSM
Asp	73.33	74.28	78.49	82.66	87.20	76.36	86.67	82.86	84.95	86.13	92.00	83.11
Thr	65.22	74.42	72.34	82.81	82.22	69.92	82.61	83.72	79.17	89.06	91.11	74.87
Ser	66.66	69.44	69.05	88.89	85.11	64.81	90.48	83.33	80.95	95.00	95.74	81.38
Glu	63.83	73.86	78.70	82.20	91.43	86.22	85.11	85.23	87.96	87.43	96.19	91.56
Pro	68.42	80.00	83.72	85.90	84.78	72.76	84.21	88.57	90.69	89.74	91.30	78.22
Gly*	----	----	----	----	----	----	----	----	----	----	----	----
Ala	66.67	70.97	78.38	83.54	84.75	73.33	88.89	83.87	89.19	88.61	91.53	84.13
Cys	38.46	64.29	71.42	50.00	66.67	61.98	61.54	75.00	80.00	63.64	77.78	79.66
Val	70.83	71.43	75.55	87.06	88.24	77.00	87.50	82.86	84.44	91.18	94.12	83.74
Meth	83.33	80.00	75.00	78.26	90.63	73.63	91.67	90.00	83.33	82.61	93.75	84.93
Iso	72.22	72.00	77.42	88.16	90.20	79.53	88.89	84.00	87.10	92.11	96.08	85.00
Leu	70.97	76.47	80.00	88.72	88.46	82.62	87.09	86.27	87.69	92.48	94.87	88.61
Phe	81.25	77.42	82.05	90.59	91.23	78.88	90.63	87.10	89.74	94.12	96.49	87.44
Lys	52.63	63.64	75.61	82.08	75.00	76.23	89.47	84.85	92.68	88.68	92.50	84.10
Arg	70.00	59.62	73.13	85.22	77.05	81.91	93.33	73.08	83.58	91.30	88.52	85.96
Mean	67.42	71.99	76.49	82.58	84.50	75.37	86.29	83.62	85.82	88.01	92.28	83.77

*** Glycine values are omitted, because of analytical errors. Uric acid is degraded to glycine and ammonia during the acid hydrolysis of excreta (Soares *et al.*, 1971).**

DISCUSSION

Undersander *et al.* (1990) stated that the jojoba oil contains no cholesterol or triglycerides and it is not broken down by normal metabolic pathways. According to this statement, the amount of oil present in JS, JM_1 and JM_2, will not be used as a source of available energy by the bird, and will be execrated by the bird unchanged. Nevertheless, the oil of the three products will contribute to their gross energy but not to the ME. ME values of JS, JM_1 and JM_2 accordingly will come only from energies of NFE, crude fiber and crude protein.

On the other hand, according to the results obtained of the available energy to the bird either as AME or TME in the present work, it will be impossible to state that the birds did not metabolize part of oil energy in the seed or the meals samples. This because the values obtained are higher than the available energy of the other non-oil components. Therefore, it is faire enough to reconsider the statement of Undersander *et al.* (1990) according to the present findings.

Considering the protein nutrition status of the jojoba meal, the measures of protein nutritive value are comparable to the other protein sources (SFM, RSM) except for SBM. The amino acids make up could easily be corrected by the addition of commercial amino acids, e.g. lysine hydrochloride and methionine or/ and by supplementation with other protein sources.

The most important aspect that should be taken into consideration in future work is the toxic compounds found in jojoba meal. These compounds, containing cyanides, affect feed intake beside their toxicity. Jojoba meal should be detoxified to be accepted as an ingredient in poultry feed. It should be noted that no toxic effects appeared in the present work because the birds were fed small amount of feed (35g) by a system called force feeding and for one time only.

In conclusion, the jojoba meal, as a by-product of jojoba seeds, is a promising feedstuff after being detoxified. In this respect, lot of biological and biochemical work are needed to be carried out.

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التقييم الكيماوى والبيولوجى لبذور وكسب الجوجوبا مقارنـاً بـبعض مصـادر البروتين النباتية الأخرى

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أجريت دراسات كيماوية وبيولوجية لمقارنة ثلاث عينات من بذور وأكساب نبات الجوجوبا مع كسب فول الصويا وكسب عباد الشمس وكسب الشلجم كمصادر بروتين نباتية شملت عينات الدراسة كل من بذور الجوجوبا وكسب الجوجوبا (١) الناتج من طحن البذور قبل استخلاص الزيت منها وكسب جوجوبا (٢) حيث كانت البذور سليمة وتم استخلاص الزيت منها بالضغط. تضمنت الدراسة كلا من:– التقييم الكيماوى والطاقة الممثلة والبروتين المهضوم والأحماض الأمينية والأحماض الأمينية المتاحة. وقد أوضحت نتائج البروتين الخام لكل من بذور الجوجوبا وكسب الجوجوبا (١) وكسب الجوجوبا(٢) وكسب فول الصويا وكسب عباد الشمس وكسب الشلجم إحتوائها على ١٤,١٨ و ٢٤,٩٥ و ٣١,٢٩ و ٤٧,٧٤ و ٣٨,٣٩ و ٣٥,٢٢% على التوالى. تم تقدير ١٠ أحماض أمينية أساسية حيث وجد أن الحامض الأمينى المحدد الأول فى كسب الجوجوبا هو المثيونين والحامض الأمينى المحدد الثانى هو الليسين. تم حساب المقاييس الكيماوية ودليل الأحماض الأمينية الأساسية لكل المواد المختبرة. وقد وجد أن الطاقة الممثلة الظاهرية (كيلو كالورى / جرام مادة جافة) ٤,٠٩٥ و ٣,١٥٣ و ٣,١١٠ و ٢,٤٩٤ و ٢,٤٢٨ و ٢,٣١٢ هى لكل من بذور الجوجوبا وكسب جوجوبا (١) وكسب جوجوبا (٢) وكسب فول الصويا وكسب عباد الشمس وكسب الشلجم على التوالى. وقد نوقشت مكافئات الطاقة الكلية الممثلة بالإضافة لبعض العلاقات البينية للأربع تقديرات للطاقة الممثلة. قدرت الأحماض الأمينية المتاحة الظاهرية والحقيقية وكان متوسط القيم للأحماض الأمينية المتاحة الظاهرية هو ٦٧,٤٢ و ٧١,٩٩ و ٧٦,٤٩ و ٨٢,٥٨ و ٨٤,٥٠ و ٧٥,٣٧%. وكذلك متوسط القيم للأحماض الأمينية المتاحة الحقيقية هو ٨٦,٢٩ و ٨٣,٦٢ و ٨٥,٨٢ و ٨٨,٠١ و ٩٢,٢٨ و ٨٣,٧٧% لكل من بذور الجوجوبا وكسب جوجوبا (١) وكسب جوجوبا(٢) وكسب فول الصويا وكسب عباد الشمس وكسب الشلجم على التوالى. تم تقدير البروتين المهضوم ظاهرياً والبروتين المهضوم حقيقياً ووجد أن كسب جوجوبا (١)، كسب جوجوبا (٢) قد سجلا قيما أعلى من بذور الجوجوبا وكانوا تقريباً على نفس مستوى القيم المقدرة للمواد المختبرة الأخرى. يجب أن يؤخذ فى الاعتبار مستقبلاً أن يتم التخلص من المركبات السامة الموجودة فى الكسب لكى يتم قبولها فى تغذية الدواجن والتى لم يظهر تأثيرها فى البحث الحالى نظرا لصغر الكمية المأكولة (٣٥ جرام) لمرة واحدة فقط ويمكن اعتباره فى هذه الحالة من مواد العلف الواعده.