Chemical and Biological Evaluation for Seed and Germ of Guar (*Cyamoposis Tetragoloba*)

Mansour S. H, H.F.A. Motawe and A. H. M. Gomaa
Central Lab for Food and Feed, Orman, Giza, Egypt.

ABSTRACT

Seeds and germs of guar were evaluated chemically and biologically in comparison with soybean meal as a reference legume for poultry nutrition.

Chemical evaluation, bioavailable energy assay and availability of amino acids were studied for guar seed (GS) and guar germ (GG) .

The results of proximate analysis indicated a low moisture content, i.e. 7.5 and 8.6% for GS and GG, respectively, and high crude protein i.e. 27.8, 38.95% for GS and GG, respectively. Ash, either extract, crude fiber and nitrogen free-extract content were 4.83, 3.46, 12.49 and 43.92%, respectively for GS and 5.54, 3.74, 14.54 and 28.63%, respectively. Ca and P contents were 0.37 and 0.52%, respectively for GS and 0.37 and 0.68%, for GG respectively.

Amino acids composition showed a recovery (% total N analyzed) up to 71.9 and 73.65 g/16g N for GS and GG, respectively, and Sulfur containing amino acids up to 4.36 and 3.23 g/16g N for GS and GG, respectively .

Sixteen amino acids were detected in varying concentration in both tested materials and among nine essential amino acids assayed, methionin, iso-leucine and threonin were the most limiting amino acids and the chemical score and essential amino acid index were estimated .

Determination of apparent metabolizable energy (AME), true metabolizable energy (TME) and their correction for zero nitrogen balance (AME_n, TME_n) were carried out. Adult cockerels were force –fed 35g of the tested materials after 24hr fasting, then excreta were collected for 48 hr.

The AME and AME_n values (Kcal/g DM) were 2.275 and 2.322 for GS, 2.177 and 2.128 for GG against 2.137 and 2.320 for soybean meal, respectively. The TME and TME_n values (Kcal/g DM) were 2.987 and 1.833 for GS, 2.918 and 1.621 for GG compared to 2.797 and 2.571 for soybean meal, respectively. Some relationships among the four estimates of bioavailable energy were discussed .

The results of apparent amino acid availability (AAAA) and true amino acid availability (TAAA) for both tested materials showed that the values of TAAA were higher than those of AAAA because of the correction for metabolic faecal and endogenous urinary amino acid excretion .

The mean value of AAAA and TAAA for GS were 60.4 and 79% and for GG 67.7 and 79.3% , respectively, against soybean meal 86 and 90% and rapeseed meal 75.4 and 81.4%, respectively. The most frequently limiting essential amino acids are methionine, cystine and lysine, it was found that TAAA of seed and germ of guar are relatively high and were over 80% .

Key words: Chemical evaluation, biological evaluation, *Cyamoposis TetragolopaL.*, Poultry.

Abbreviations: GS, guar seed; GG, guar germ, DM, dry matter;CP, crude protein; EE, ether extract; CF, crude fiber, NFE, nitrogen free-extractive; AAAA; apparent amino acid availability; TAAA; true amino acid availability

INTRODUCTION

A large majority of the world's population and livestock subsists on diets predominantly of vegetable protein. Protein malnutrition, deficiency and shortage has engaged the attention of food and feed scientists in the past and nowdays. In order to use and introduce an unconventional feedstuff, it should be submitted to bioavailablity assay of its nutrients in particular to energy and amino acids.

Guar (whole plant) as summer forage and hay were tested with sheep by Gabra et al (1990 a, b) and as seeds by El-Nouby (1962) aand as germs by Haready and Hamza (2001 a, b).

Guar germ have high protein content (38.7%), reasonable amino acids composition and high energetic value (4,169 Kcal/g DM), Haready and Hamza (2001a).

Pervious studies have indicated that correcting excreta energy to nitrogen equilibrium may substantially affect true metabolizable energy values of feedstuffs to be used in poultry feed formulations, Sibbald (1976, 1977, 1980 and 1986) and El-Sherbiny (1990).

The varied availability values among individual amino acids in feedstuff are sufficiently extensive to be taken into consideration in the formulation of poultry rations and indicated the advantage of balancing the dietary protein on the basis of available amino acids, Elwell and soares (1975); Robel and Frobish (1977).

The objective of this study is to evaluate the chemical composition, composition and scoring analysis of amino acids, apparent and true availability of amino acid and bioavailable energy.

MATERIALS AND METHODS

This study was carried out at Central Laboratory for Food and Feed,Agriculutal Research center, Giza, Egypt.

Guar seeds were obtained Agricultural station of Agricultural research center at Giza. A portion of the seeds were submitted to the separation of the germs at Dyeing, Printing and Textile Auxiliaries Department, Textile Industries Research Division, National Research Center, Dokki, Cairo , Egypt.

Mechanical separation procedure was done so as to separate the endosperm of seeds for gum production. i.e. Galactomanan for industrial use, and the germ for the target evaluation. Since the three components of seed, namely hull, endosperm and germ differ in their hardness properties, Whistler (1959), the procedure adopted was carried out as follows: the clean dry seeds were ground under mild conditions using a mixer. The ground seeds were then sieved to remove the germs which posses the lowest hardness, Nassar (1990).

- Proximate composition: Moisture, ether extract (EE), crude fiber (CF) and ash were determined by the method of the Association of Official Analytical Chemists, A.O.A.C.(2000) using triplicate samples for each determination. The amount of nitrogen free-extractive (NFE) was obtained by difference. Ca and P were determined according to the method described in the A.O.A.C. (2000). Amino acid composition of the test matrerials and excreta were determined according to Official Journal of the European communities (1998). High Performance Amino Acid Analyzer, 7300 was used.

- On the basis of amino acid composition, the chemical score (SC) and essential amino acid index (EAAI) were calculated according to Block and Mitchel (1946) and Oser (1951), respectively.

- The metabolizable energy assay was carried out according to the TME system described by Sibbald (1976) and developed by Sibbald (1986). Adult single Hubbard cockerels of nearly similar body weight were individually placed in metabolic cages. Four cockerels for each tested material. The birds were fasted for 24hr to empty their digestive tract and then force-fed 35g of the tested material. Group of 8 birds were fasted served as a negative control to estimate the metabolic faecal and endogenous urinary energy. Force feeding was accomplished by inserting a long stem funnel into the crop via the oesophagus. The tested material, in a powder form, was poured into the funnel and pushed into the crop with a plunger. Excreta were quantitatively collected after 48hr period from the fed and fasted birds, dried, allowed to equilibrate with atmospheric moisture, weighed and then ground. Sample of ground feed and excreta were analyzed for gross energy (GE) values using adiabatic oxygen bomb calorimeter. Dry matter and nitrogen of feed and excreta were determined according to the Official Method of Analysis (A.O.A.C.2000). The AME, AMEn, TME and TMEn calculations were based on the equations of Sibbald (1976) as follows:

- AME = { energy feed – energy excreta } / feed intake.
- TME = AME + { average energy endogenous / feed intake }
- AMEn = TME – (8.22 * N balance of endogenous) / feed intake
- TMEn = AME – { energy excreta + (8.22* N balance of endogenous) feed intake }

Where, 8.22 = the energy in Kcal / g N retained or lost by bird.

- The energetic values of AME, AMEn, TME and TMEn were calculated as described by Mohamed et al (1988).

- The 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),

RESULTS AND DISSCUTION

The proximate composition of guar seed (GS) and guar germ (GG) is presented in Table (1).

The amino acids composition of guar seed and guar germ are presented in Table (2).

Crude protein content in the tested feedstuffs are reasonably high when they compared with some other plant protein sources commonly used in animal and poultry rations. A comparison was made between the experimental feedstuffs and the following plant protein sources, i.e. soybean meal (SBM), cotton seed meal (CSM) and rape seed meal (RSM) for crude protein content (%), recovery of amino acids (g/16g N) and sulfur amino acids (g/ 16g N), and the results are quoted in Table(3).

Reasonable crude protein content for guar germ (38.95%) and relatively low content for guar seed (27.8%) could be observed as compared with SBM, CSM and RSM crude protein contents as shown in Table (3).

The recovery of amino acids (RAA) showed lower values up to 71.9 and 73.65 for GS and GG, respectively, compared with 99.82, 88.72 and 91.09 g/16g N for SBM, CSM and RSM, respectively.

The sulfur amino acids (SAA) content of both experimental feedstuffs (4.36 and 3.23) were higher than the content of SAA in SBM and CSM, however, the values were slightly lower than in RSM (4.75).

A comparison was made to evaluate the experimental feedstuffs with other plant protein sources for the following nutrients:

Ether extract contents (%), crude fiber contents (%) and nitrogen free extractives (%), and the results were quoted in Table (4).

The results of ether extract contents (EE) showed that GE (3.46%) and GG (3.74%) had higher values than SBM (1.11%) and CSM (2.55%), however, both GS and GG had lower contents than RSM (10.04%).

Slight high values of crude fiber contents in this comparison for both GS (12.49%) and GG (14.54%) against SBM (9.12%, CSM (11.45%) and RSM (14.19%). The high value of crude fiber content og GG refer to some of the seed cortex was adhered with the germs during the separation processes.

Nitrogen free extractives content (NFE) showed the highest value was for

GS (43.92%) and the lowest value was for CSM (22.85%). Since, NFE contents were calculated by difference, the differences which appeared between the feedstuffs, are due to the contribution of other nutrients for each feedstuff in the comparison.

A comparison was made between ash content (%), calcium content (%), phosphorus content (%) and calcium to phosphorus ratio in guar seed (GS) and guar germ (GG) against soybean meal SBM), decorticated cotton seed meal (CSM) and rapeseed meal (RSM), and the results are quoted in Table (5).

The results of ash content showed that the tested seed and germ of guar containing less ash content than RSM, SBM and CSM. The higher value was for RSM (7.94%) and the lowest value was for guar seed (4.83%).

Calcium contents in GS (0.37%) and CSM (0.37%) were higher than the contents in SBM (0.3%) and CSM (0.2%), but their values were lower than RSM (0.65%). The trend was with the Ca as per cent of ash.

Phosphorus contents showed that both tested feedstuffs are containing less than CSM and RSM, however, GG was relatively the same like SBM.

The essential amino acid composition , chemical score (CS), essential amino acid index (EAAI), limiting amino acids (LAA) for guar seed and guar germ, soybean meal, rapeseed meal, chick requirements of amino acids and the amino acid composition of whole egg are presented in Table (6).

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).

Herein, the calculation of chemical score was based on the suggested chick requirements of amino acids, NRC (1994).

The results of chemical scores showed that GS (37.79) and GG (41.47) had lower value than SBM (52.53) and RSM (68.66).

The essential amino acids index (EAAI) was calculated, where, the nine essential amino acids were considered, and the index was defined as the geometric mean of the whole egg ration of these acids.

The results showed that EAAI value of GS (36.79) was lower than GG (55.05), however, both of them were lower than the values of SBM (82.71) and RSM (62.91).

According to the calculated value of chemical score, the limiting amino acids (LAA) were defined for each tested feedstuff in descending order, i.e. first LAA, second LAA and third LAA, as shown in Table (6).

The limiting amino acids of GS are Methionine (1^{st} LAA), threonine (2^{nd} LAA), however, the limiting amino acids of GG are methionine (1^{st}LAA), iso-leucine (2^{nd} LAA) and threonine (3ed LAA).

Generally, both tested feedstuffs are deficient in methionine, threonine and iso-leucine in different order. In cereal based diets, both tested feedstuffs, could be included in rations with the supplementation of deficent amino acids, in particular to methionine.

The gross energy (GE), metabolized energy values and coefficients of metabolized gross energy values were quoted in table (7).

The GE of guar seeds (GS) and guar germ (GG) are 4.359 and 4.343 Kcal/g DM, respectively, which represent 94.8% and 94.5% of GE of soybean meal (4.596 Kcal/g DM, studied by Mohemed et al (1988) and represent 91% and 90.6% of GE of soybean meal (4.792 Kcal/g DM) which is the average of 19 samples of soybean meal analysed by Sibbald (1986).

The variation among the four values of ME in the present study and those for soybean meal is mainly due to the variability of nutrients composition and the source of each ingredient.

Moreover, the GE content of any feedstuff is not necessarily all available to the bird .

Therefore, it was necessary to measure the bioavailability of energy, sibbald (1976, 1977, 1980 and (1986), Yamazaki (1987), Mohamed et al. (1988) and El Sherbiny (1990).

The AME values of guar seed (GS) and guar germ (GG) showed slight difference between GG and soybean meal up to 0.040 Kcal/g DM, however the difference between soybean meal and GG relatively high up to 0.138 Kcal/g DM.

When the AME values for GS and GG were corrected to zero nitrogen balance, the AME_n values became slightly higher than its corresponding AME values. This because the cockerels were in a negative nitrogen balance during the assay.

The Correction of AME for the metabolic faecal plus endogenous urinary energy (endogenous energy losses) caused the TME values be greater than the corresponding AME values for all ingredients .

The increase in TME values were 31.3%, 34% and 30.9% of their corresponding AME values GS, GG and soybean meal, respectively.

Yamazaki (1987) obtained wide range of variation between AME_n and TME values from 9.5% for sesame seed meal to 30.6% for rapeseed meal.

Haready and Hamza (2001a) found less variation for guar germ up to 32.9% against the recent study 30.9% for GG.

The TME_n values were lower than the corresponding uncorrected TME values. This is due to the larger nitrogen losses by the fasted cockerels than by the fed cockerels, parsons el al (1982); Haready and Hamza (2001b).

The coefficient of GE metabolized values were calculated and quoted in table (7) .

The calculated coefficients followed similar trends as those of different metabolized energy values, being the highest for TME which give up 68.5 for GS, 67.2% for GG and 60.9% soybean meal. However, the lowest coefficients for TME_n being 37.3% for GG and 42.1% for GS. Haready and Hamza (2001b) found the same trend with TME coefficients .

The results of apparent amino acid availability (AAAA) and true amino acid availability (TAAA) for guar seed (GS) and guar germ (GG) are shown in Table (8) .

It is clear that the values of TAAA were higher than those of AAAA because of the correction for metabolic faecal and endogenous urinary amino acid excretion .

The AAAA and TAAA values for GS were 60.4 and 79% and for GG 67.7 and 79.3%, respectively.

Compared with Soybean meal, the apparent and true amino acid availability of GS on GG were markedly lower than the corresponding values of 86 and 90% for soybean meal obtained by El-sharbiny et al (1988) using the same technique of sibbald (1976 and 1979). The TAAA of both tested materials were also lower than the value of 92% reported by Engster et al (1985) for soybean meal .

Compared with rapeseed meal, the apparent and true were lower than the corresponding values of 75.4 and 81.4% for rapeseed meal, El-Sherbiny et al (1994b).

This indicated that the AAA of guar seed and guar germ are lower than those observed for soybean meal and rapeseed meal, which confirmed the superiority of soybean meal protein quality compared with that of either guar seed or guar germ .

The range TAAA of individual amino acid in guar seed was from 60.6% for alanine to 95.2% for serine.

However, the range TAAA of individual AA in guar germ was from 52.4 for iso - leucine to 88.1% for asparatic acid.

Comparing to mean values of AAA and TAA the most frequently limiting essential amino acids are methionine, Cystine and lysine, it was found that in TAAA of seed and germ of guar are relatively high and was over 80% .

Conclusion

From the results of chemical and biological evaluations of the tested guar seed and guar germ, it can be concluded that seed and germ of guar can be introduced in poultry feeds as protein concentrate for the following advantages:

- High protein content with reasonable amino acid composition .
- Reasonable true availability of amino acids and the availability of sulfur amino acid is more than 80% .
- High content of energy in both tested materials .
- Low fiber content in both tested materials .

Reasonable ash content with calcium and phosphorous content similar to other used plant protein meals

Table (1): The proximate composition (%) of guar seed and guar germ on dry Matter basis.

Feed	DM	CP	EE	CF	ASH	NFE	Ca	P
Guar seed	92.5	27.8	3.46	12.49	4.83	43.92	0.37	0.52
Guar germ	91.4	38.95	3.74	14.54	5.54	28.63	0.37	0.68

Table (2): The amino acid composition of guar seed and guar germ as (%) and g/16g N.

Amino acid	Guar Seed		Guar germ	
	%	g/16g N	%	g/16g N
Aspartic acid	2.40	9.34	3.50	9.83
Methionine	0.21	0.82	0.32	0.90
Threonine	0.55	2.14	0.94	2.64
Serine	0.59	2.30	1.21	3.40
Glutamic acid	4.32	16.81	5.73	16.10
Proline	0.70	2.72	1.08	3.03
Glycine	1.34	5.21	1.86	5.22
Alanine	0.94	3.66	1.39	3.90
Cystine	0.91	3.54	0.83	2.33
Valine	0.69	2.68	1.05	2.95
Isoleucine	0.56	2.18	0.85	2.39
Leucine	1.18	4.59	1.80	5.06
Phenylalanine	0.80	3.11	1.21	3.40
Histidine	0.60	2.33	0.88	2.47
Lysine	0.94	3.66	1.42	3.99
Argnine	1.75	6.81	2.15	6.04
Total Sulfur amino acids	1.12	4.36	1.15	3.23
Recovery of amino acid (% total N analyzed)		71.90		73.65

Table (3): Crude protein content (CP), recovery of amino acids (RAA) and total sulfur amino acids (SAA) for guar seed (GS), guar germ (GG), soybean meal(SBM),cotton seed meal (CSM)and rapeseed meal(RSM).

Nutrient	GS	GG	SBM*	CSM*	RSM**
CP (%)	27.80	38.95	42.67	47.56	39.85
RAA (g/16g N)	71.90	73.65	99.82	88.72	91.09
SAA (g/16g N)	4.36	3.23	2.35	2.84	4.75

* data adopted from Mohamed et al (1988)

** data adopted from sibbald (1986)

Table (4): Ether extract (EE %), crude fiber (CF %) and nitrogen free-extractive (NFE%) for guar seed and guar germ in comparison with soybean meal, cotton seed meal and rapeseed meal.

Nutrient	GS	GG	SBM*	CSM*	RSM**
EE	3.46	3.74	1.11	2.55	10.04
CF	12.49	14.54	9.12	11.45	14.19
NFE	43.92	28.63	31.09	22.85	30.06

*Data adopted from Mohamed et al (1988).

**Data adopted from Nwokolo et al (1976).

Table (5): Ash content (%), calcium content (%), phosphorus content (%), and calcium: phosphorus ratio and Ca % of ash for guar seed and guar germ in comparison with soybean meal (SBM), decorticated cotton seed meal (CSM) and rapeseed meal (RSM).

Nutrient	GS	GG	SBM*	CSM*	RSM**
Ash	4.83	5.54	6.50	6.40	7.94
Ca	0.37	0.37	0.30	0.20	0.65
P	0.52	0.68	0.65	1.00	1.35
Ca : P	1:1.4	1:1.8	1:2.2	1:5	1:2.1
Ca % of ash	7.7	6.7	3.1	4.6	8.2

*Data adopted from Anominous, by Ministry of Agriculture, Egypt (2000).

**Data adopted from Sibbald (1986), mean values of 14 samples

Table (6):Essential amino acid composition, chemical score (CS), essential amino acid index (EAAI), limiting amino acids (LAA) for guar seed (GS), guar germ (GG), soybean meal (SBM), rapeseed meal (RSM).

Amino Acid	GS	GG	SBM*	RSM**	Chick*** requirement.	Whole Egg****
Arg	6.81	6.00	7.45	4.89	6.26	6.4
His	2.33	2.47	2.28	2.47	1.52	2.1
Lys	3.66	3.99	6.62	4.55	5.22	7.2
Cys	3.54	2.33	1.21	1.85	1.87	2.4
Met	0.82	0.90	1.41	1.49	2.17	4.1
Thr	2.14	2.64	4.18	4.18	3.48	4.9
Iso-I	2.18	2.39	5.21	3.26	3.48	8.0
Leu	4.59	5.06	7.58	6.63	5.87	9.2
Val	2.68	2.95	5.38	4.16	3.57	7.3
EAAI	36.79	55.05	82.71	62.91		
CS	37.79	41.47	52.53	68.66		
1. LAA	Met	Met	Met	Met		
2. LAA	Thr	Iso-I	Cys	Arg		
3. LAA	Iso-I	Thr	---	Cys		

[redacted]Data adopted from Mohamed et al (1988).
** Data adopted from El-Sherbiny et al (1994a).
***NRC (1994).
**** Block and Mitchell (1946).

Table (7): The metabolizable energy values (Kcal/g DM) and coefficients of gross energy metabolized for guar seed (GS) and guar germ (GG) in comparison with soybean meal (SBM).

Feed	GE	AME	AMEn	TME	TMEn	Coefficients of metabolized GE			
						AME	AMEn	TME	TMEn
GS	4.359	2.275	2.322	2.987	1.833	52.2	52.3	68.5	42.1
GG	4.343	2.177	2.128	2.918	1.621	50.1	50.0	67.2	37.3
SBM*	4.596	2.137	2.320	2.797	2.571	46.5	50.5	60.7	55.9

*Data adopted from Mohamed et al (1988).

Table (8): Apparent and true amino acid availability of guar seed and guar germ.

Amino acid	Guar			
	Seed		Germ	
	AAAA*	TAAA*	AAAA	TAAA
Asp	75.0	84.5	81.4	88.1
Met	71.4	85.7	72.7	81.8
Thr	47.4	79.0	59.4	78.1
Ser	61.9	95.2	70.7	87.8
Glu	82.1	90.7	79.9	86.6
Pro	52.0	76.0	62.2	78.4
Gly	46.8	74.5	57.2	77.8
Ala	45.5	60.6	53.2	63.8
Cys	65.6	81.3	67.9	85.7
Val	45.8	66.7	54.3	68.6
Iso-I	55.0	75.0	58.6	52.4
Leu	58.5	75.6	65.6	77.1
Phen	60.7	75.0	68.3	78.1
His	47.6	71.4	70.0	86.7
Lys	66.7	81.8	75.0	85.4
Arg	83.6	90.2	86.3	91.8
Mean	60.4	79.0	67.7	79.3

AAAA = Apparent amino acid availability
TAAA = True amino acid availability

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الملخص العربي

التقييم الكيماوى والبيولوجى لبذور وأجنة الجوار

منصور سيد هريدى – هادى فتحى عباس مطاوع – أشرف هاشم محمد جمعة

أجريت تجربة للتقييم الكيماوى والبيولوجى لبذور وأجنة الجوار مقارنة مع كسب فول الصويا كمصدر بقولى لتغذية الدواجن تم التقييم الكيماوى وتقدير الطاقة التمثيلية ومعامل الاستفادة من الأحماض الأمينية لكل من بذور الجوار وجنين الجوار .

أظهرت نتائج التحليل الكيماوى انخفاض محتوى الرطوبة وهى 7.5%، 8.6% لكل من البذور والأجنة على التوالى، ومحتوى بروتين عالى 27.8% ، 38.95% لكل من البذور والأجنة على التوالى. محتوى كل من الرماد ومستخلص الأثير والألياف الخام والمستخلص الخالى من النيتروجين كانوا 4.83%، 3.46%، 12.49% و 43.92 على التوالى للبذور و 5.54%، 3.74%، 12.54% و 28.63% على التوالى للأجنة. محتوى كل من الكالسيوم والفوسفور كانت 0.37%، 0.52% على التوالى للبذور و0.37% و 0.68% على التوالى للأجنة وتركيب الأحماض الأمينية أظهرت أن الكلى من النتروجين هو 71.9% و 73.65جرام/ 16 جرام نتروجين للبذور والأجنة على التوالى والأحماض الأمينية المحتوية على الكبريت كانت 4.36 ، 3.23 جرام/ 16 جرام نتروجين للبذور والأجنة على التوالى. تم الكشف عن ستة عشر حامض أمينى بتركيزات مختلفة فى كل من المادتين المختبرتين. ومن بين هذه الأحماض تسعة أحماض أمينية ضرورية وهناك الأحماض الأكثر تحديدا وهم ميثيونين وأيزوليوسين والثرونين. تم تقدير المقياس الكيمائى ودليل الأحماض الأمينية الضرورية.

تم قياس الطاقة التمثيلية الظاهرية والحقيقية وتصحيحهم للصفر النتروجينى وقد تم تزغيط ديوك بالغة بـ 35 جرام من المادة المختبرة بعد صيام 24 ساعة وتم تجميع الزرق لمدة 48 ساعة .

وقد قدرت الطاقة الظاهرية والظاهرية المصححة للنتروجين بالكيلو كالورى لكل جرام مادة جافة وكانت 2.275، 2.322 للبذور و2.177 و 2.128 للأجنة مقابل 2.137 و 2.230 لكسب فول الصويا على التوالى. وقد قدرت الطاقة الحقيقية والحقيقية المصححة للنتروجين بالكيلو كالورى لكل جرام مادة جافة وكانت 2.987 ، 1.833 للبذور و 2.918 و 1.621 للأجنة بالمقارنة إلى 2.797 و 2.571 لكسب فول الصويا على التوالى .

وقد تم مناقشة بعض العلاقات بين الأربعة مقدرات للطاقة التمثيلية وقد أظهرت نتائج معامل الاستفادة من الأحماض الأمينية الظاهرية والحقيقية لكل المادتين المختبرتين أن قيم الحقيقية أعلى من الظاهرية وذلك يرجع إلى التصحيح للنتروجين للأحماض الأمينية المخرجة داخليا فى الزرق والبول .

وقد تم تقدير القيم المتوسطة لكل من الظاهرية والحقيقية للبذور فكانت 60.4% و79% وللأجنة كانت 67.7% و 79.3% على التوالى بالمقارنة إلى كسب فول الصويا فكانت 86% و 90% أما كسب الشلجم فكان 75.4% و 81.4% على التوالى.

وقد وجد أن الأحماض الضرورية المحددة للبذور والأجنة كانت أعلى من 80% وهى المثيونين، السستين، والليسين من النتائج السابقة ينصح باستخدام بذور وأجنة الجوار فى علائق الدواجن مع الأخذ فى الاعتبار نسبة الألياف والأحماض الأمينية الضرورية .