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Biological Value of Water Lentil Plants and Microscopic Algae as Rich Protein Sources in Poultry Rations.

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THE WATER lentil plants and microscopic algae found in the scum of ponds and slow moving water were chemically and nutritionally analysed. The morphology and texonomy of these water plants and microscopic algae were described. The determination of amino acids and the predicted biological value were studied. Two pilot experiments on growing Pekin ducklings were conducted to feed them on the fresh and air dried lentil plants and algae.

It was found that these water plants composed of 29.6% crude protein and contains considerable amount of essential amino acids, but they were of lower biological value if compared to that of the whole hens eggs. However, these plants were not toxic as the Marine algae, consequently could be used in poultry rations in proper percentage as major plant protein sources.

The shortage of proteins in a great many countries respesents a soundy problem and need various solutions. Searching for new food sources that can be mass produced at low cost, has led to the culture of various microorganisms such single cell proteins as yeast or multicell protein's as algae, *i.e.*, Spirolina (Clement, 1975).

It was intended to cast light on the chemical analysis, biological value and to carry out of pilot experiments on water lentil plants and microscopic algae which may be harvested by the farmers population living in the vicinity of ponds, and slaw moving water in Egypt. These plants with the other microscopic algae may be used as new protein rich sources in poultry rations.

Material and Methods

Water lentil plants mixed with the other microscopic algae were collected from the local ponds of Sharkia Governorate as they are commonly used by the farmers in this territory for feeding poultry since a long time ago.

Chemical analysis

Samples of these plants were used for chemical analysis therefore, were separated to fresh lentil plants and fresh algae to determine the amino acids composition and biological value in each.

Moisture, crude protein, petrolium ether (60-80°), ash were done for samples of water lentil plants and microscopic algae and their mixtures according to the methods of the A.O.A.C. (1970).

Determination of amino acids

Water lentil plants and microscopic algae (0.3 g) were hydrolysed, separately, with 8N constant boiling hydrochloric acid at 105° for 18hr in sealed tubes. Amino acids were converted to N-trifluoroacetyl n-butyl derivatives using the method of Gehrke (1968). The amino acid derivatives were put into a borosilicate glass column (6 long $\frac{1}{8}$ ID) packed with 1%(W/W) ethylene glycol adipate coated on a 100/120 mesh preheated chromoeorb G. The injector and detector temperatures were 200 and 250°, respectively, and the column initial temperature was 70° and programmed 4°/min with maximum temperature 200°. Individual amino acid was calculated according to the method of Gehrke (1968) using ornithine as internal standard.

The amount of isoleucine and therionine was calculated by substracting the amount of glycine and proline, determined according to the method of Block (1958), from the amount of glycine + isoleucine and therionine + proline determined by G.L.C. technique, respectively.

Arginine and histidine were determined colourmetrically according to the method of Macpherson (1942).

Tryptophan was determined colourimetrically in the alkaline hydrolysis according to the method described by Blauth *et al.* (1963).

Determination of predicted biological value was calculated according to the method of Oser (1951).

Two pilot experiments were carried out on 40 Pekin ducklings of 3 week old. The first experiment was conducted to test the toxicity by feeding the fresh mixture of water lentil plants and microscopic algae for three weeks period corresponding to the same number of ducklings fed normal growing ration of 15.7% crude protein and 2874 ME kcal/kg, calculated after Erb (1976). The second experiment was performed on 60 dayold ducklings divided into two similar groups. The first group raised on the former growing ration

and the second were raised on a ration composed of 50% ground air dried of lentil plants and algae and 50% growing ration. The mortality rate (%) and body weight was recorded at weekly interval in the first experiment, while the body weight was recorded at biweekly interval in the second experiment. Statistical analysis was done according to Snedecor and Cochran (1967).

Results and Discussion

Morphology and taxonomy of water lentil plants and algae

The water lentil plants are *Hydrophytes* belong to *Lemnaceae* family, which includes two genera, *Lemma* and *Wolffia*, comprises the smallest flowering plants (Core, 1955). The characteristics of these two genera can be summarised as follows :

a. Wolffia arrhiza

The stem is very small, disclike, dorsiventral, green with similar small branches either separate or still attached to it. The plant is rootless and devoids of vascular tissues. The flowers initiate in a pocket on the ventral surface of the stem and penetrate through the dorsal one. They are very small, unisexual and collected as inflourescences. In each plant there is an inflourescence comprises of two flowers only, the male flower is represented by a stamen corresponding to a carpel in female one.

b. Lemna trisulca

The stem looks like that of *Wolffia arrhiza*, except the presence of a central simple vascular bundle and a root attached to its ventral surface. The inflourescence, which initiates in a pocket on the ventral surface of the stem includes three flowers, two of them are males and the third is female. These flowers are alike to those described before in *wolffia arrhiza*.

Microscopic studies of numerous samples showed that these plants in the natural conditions are mixed with some water plants such as the protozoa and different types of algae which belong to certain divisions of the plant kingdom and which were identified as follows :

Algae	Division
Oscillatoria	*Cyanophyta*
Euglena	*Euglenophyta*
Chlamydomonas	*Chlorophyta*
Sbirogyra	,,
Cladophora	,,
Diatomes	*Chrysophyta.*

These water plants and algae are common in the scum of ponds and slow moving water certainly mixed with snails during summer months and even the whole year except winter season. The percentage of the water microscopic algae ranged from 8% to 10% of the mixture.The PH value of different water samples as media for these plants was found to be 7 - 10..

Chemical and biological evaluations

Results illustrated in Table 1 showed that the water lentil plants and microscopic algae as well as their mixtures having considerable amounts of crude proteins ranged from 26.03% to 30.12% (on dry basis). These considerable amounts of protein led the authors to investigate them chemically and biologically in order to cast light on their nutritional value especially in poultry feeding.

TABLE 1. Chemical analysis of water lentil plants and microscopic algae as well as thei mixture.

Chemical analysis (on dry weight basis)	Water lentil plants %	Microscopic mixture	
		Algae %	%
Crude protein %	30.12	26.03	29.62
Crude fibre %	8.65	5.00	7.52
Ash %	3.71	2.75	3.59
Petrollium ether Extract %	1.71	1.93	1.73
Carbohydrate %	55.81	64.29	57.54

The amino acids composition water lentil plants and microscopic algae are shown in Table 2. It was observed that lentil plants contained, relatively, higher level of aspartic acid, glutamic acid, glycine isoleucine, methionine, tyrosine and valine than those found in microscopic algae. However, the microscopic algae contained more leucine, phenyl alanine, lysine, arginine and tryptophane than those found in lentil plant samples. No marked differences were presented in the other aminoacids. From the data, it was clear that lentil plants were characterized by their high content of sulfercontaining amino acids, while the microscopic algae were characterized their high content of lysine.

From Table 3, it is clear that the lentil plants were difficient in lysine, while microscopic algae were difficient in lysine, methionine and cystine when compared with those of the whole hen's egg as proposed by WHO (1965). Moreover, the provisional mixture of pure amino acids proposed under the FAO

system (1957) when used to compare the nutritive value of these proteins indicated that lysine was the limiting amino acid in lentil plants and microscopic algae with protein score of 13 and 26, respectively. The predicted biological value (Table 4) was found to be 19.54 and 26.22 in lentil plants and microscopic algae, respectively.

TABLE 2. Amino acid composition of water lentil plants and microscopic algae.

Amino acid (g/16 g N)	Water lentil plants	Microscopic algae
Alanine	0.25	0.17
Valine	2.50	1.00
Glycine+isoleucine	4.16	2.88
Leucine	0.50	1.00
Proline+threonine	3.32	3.79
Serine	1.50	1.72
Cystine	0.96	0.75
Methionine	1.52	0.83
Phenyl alanine	0.83	1.14
Aspartic acid	2.00	1.80
Glutamic acid	3.01	2.69
Tyrosine	3.72	1.57
Lysine	0.50	1.10
Arginine	1.30	1.80
Histidine	1.60	1.70
Tryptophan	0.90	1.20

Results shown in Table 5 indicated that there was no mortality throughout the three weeks of the experiment, either by feeding fresh water plant mixture or the conventional growing ration in the treated or control groups. So, it could be concluded that there was no toxic material and consequently no toxic effect on the survived birds fed the fresh mixture of lentil plants and algae It was emphasized, however, by Salib *et al.* (1977) that the Marine algea was toxic for feeding mice as they contain toxic material either fresh or air dried. The decrease in body weight of the birds fed the fresh water lentil

plants and microscopic algae mixture was due to the high moisture and imbalance of nutrient requirements in this ingredient as a ration for the growing ducklings and its difficiency in lysine and most essential amino acids (Table 3) and consequently their low biological value (Table 4). It could be recommended that using the water lentil plants and algae mixture in feeding poultry should not be as fresh, but air dried and as one of the major plant protein sources in the ration.

TABLE 3. Essential amino acid patterns*.

Amino acid**	Hen's egg	Water lentillplants	Microscopic algae
Isoleucine	129	117	74
Leucine	172	61	78
Lysine	125	34	41
Total aromatic A.A.	195	274	137
Phenyl lanine	114	110	79
Tyrosine	81	164	58
Total S—containing A.A.	107	136	89
Methionine	61	78	31
Cystine	46	58	28
Threonine	99	175	86
Treptophan	31	54	44
Valine	141	159	82

* Calculated as described by WHO (1965).
** From mean amino acid content.

Results represented in Table 6 showed that the ducklings fed ration of 50% air dried lentil plants and algae mixture were similar in growth to those fed the conventional ration. However, the body weight of treated group birds were less than those of the control group ones at 8 weeks of age. The difference in body weight between the two groups was statistically, highly significant. Body weight of birds aged 8 weeks in the treated group was similar to that of birds aged 6 weeks only in the control group. It could be concluded that the air dried mixture of lentil plants and microscopic algae should be used in lower level in poultry rations as major plant protein source for the well balance of these rations. Further investigations are going on to study the proper percentage of these water plants as air dried ingredient in growing and laying rations for chickens, as well as the digestibility trials.

TABLE 4. Protein scores and predicted biological value of water lentil plants and microscopic algae.

Amino acids*and biological value	Provisional amino acid pattern	Water lentil plants	Microscopic algae
Isoleucine	270	122	125
Leucine	306	63	131
Lysine	270	35	69
Phenyl alanine	180	114	134
Tyrosine	180	170	98
Methionine	144	81	52
Cystine	126	60	47
Threonine	180	182	146
Tryptophan	90	56	75
Valine	270	156	138
Protein score**	100	13	26
Limiting amino acid	—	lysine	lysine
Predicted biological value ***	—	19.54	26.22

* mg amino acid/gN.
** Calculated according to Oser (1951).
*** Food and Agricultural Organization of the United Nations (1957).

TABLE 5. Live weight in grams of Pekin ducklings fed on growing ration and mixture of fresh water lentil plants and microscopic algae (Test of toxicity).*

Age in weeks	Live weight (g) on growing ration	Live weight(g) on fresh plant
3	234.8	291.2
4	379.0	350.0
5	560.0	369.4
6	739.3	406.3

* Mortality % = Zero.

TABLE 6. Live weight of Pekin duckling fed normal and treated rations.

Age in weeks	Live weight (g) on 100% growing ration	Live weight (g) on 50% growing ration + 50% air dried—plant	"t" test value
Day old	56.5	55.9	
2 weeks	307.2	247.9	2.8**
4 weeks	745.7	497.9	3.5**
6 weeks	1146.9	824.9	2.3**
8 weeks	1533.6	1143.8	3.6**

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القيمة البيولوجية لنباتات عدس الماء والطحالب المائية كمصادر غنية بالبروتين فى علائق الدواجن

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تم تحليل نباتات عدس الماء والطحالب المائية التى توجد فى صورة ريم فى المياه الراكده وذلك من الناحية الكيميائية والغذائية • كما تم وصف هذه النباتات من الناحية المورفولوجية والتقسم النباتى•وقد قدرت الاحماض الأمينية بطريقة التفريد الغازى السائلى كما تم حساب القيمة البيولوجية لهذه النباتات أيضا • وقد أجريت تجربتان على البط البكين النامى لتغذيته بهذه النباتات طازجة وجافة هوائيا • وقد وجد أن خليط نباتات عدس الماء والطحالب تحتوى على ٢٩ر٦٪ بروتين كما ثبت أنها تحتوى على نسبة لا بأس بها من الاحماض الأمينية الأساسية ولكنها أقل من القيمة البيولوجية عند مقارنتها بالقيمة البيولوجية للبيض • كما ثبت أن هذه النباتات غير سامة علائق الدواجن كمصدر غنى للبروتينات النباتية ولكن بالنسبة المضبوطة فى بمقارنتها بطحالب مياه البحار التى ثبت سميتها وعلى ذلك يمكن استخدامها فى العليقة •