PROTEIN QUALITY OF DRIED CORN STEEP LIQUOR

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SUMMARY

Dried corn steep liquor (DCSL) namely Aminofeed was chosen according to it's protein content (43.5%) to be incorporated in chick diets. In the present study it was subjected to amino acid analysis and biological evaluation using Hubbard broiler chicks.

The Amino acid make-up of the DCSL was compared with the amino acid requirement of broiler chicks. Methionine was the first limiting amino acid, chemical score was 30. Lysine was found to be 33% available. Recalculating chemical score according to available lysine showed that lysine is the first limiting amino acid, chemical score was 21.

Chick bioassay revealed that Total Protein Efficiency, (TPE) of the control diet (soya diet) was 2.64. Whereas DCSL diet gave markely lower TPE value, 1.49. Supplementation of the diet containing DCSL with lysine or methionine or lysine plus methionine gave different growth chick responses as TPE value.

Results showed that the poor protein quality of DCSL could be relatively improved by supplementing DCSL diets with the limiting amino acids.

INTRODUCTION

Corn steep water is a waste product of steepting process used in the corn wet milling industry in preparation of corn for grinding in starch manufacture. The steeping removes most of the water soluble materials including sugar, free amino acids, some proteins, vitamins and minerals. In US, the solubles are recovered by concentrating the steep water and mixing it with gluten. It is also used as a nutrient in manufacturing antibiotic or as feed supplement (corn fermentation solbules).

However, corn steep water concentrate is not one of the 29 official ingredients derived from corn which are approved by the American Association of Feed Control Officials.

In Egypt, this non traditional material has been considered as waste product of no value. About 100 cubic meters/day corn steep liquor are derived as a by product (50% dry matter). Recently, Starch Glucose Company produced the corn steep water in a dried form (92% dry matter) from a new established pilot plant. Half of the dry matter is in the form of crude protein.

The aim of the present study is to evaluate the protein quality of this material chemically and biologically.

MATERIAL AND METHODS

Material:

The Dried Corn Steep Liquor (DCSL) used in the present work was produced from a pilot plant established in the Starch and Glucose Company, Mostrood Manufacture. The drained corn steep water (8% total solids) was concentrated in the evaporators to be around 50% dry matter and then filtered using special ultra filteration units to increase dry matter to 70-80%. Thereafter, the material was dried using hot air. The final product contained approximately 92% dry matter.

Methods:

Chemical and biological tests of the studied sample were carried out in the Egyptian Danish Protein Laboratory for Chemical and Biological Analysis.

Chemical Analysis:

Dry matter, protein, ash, fibre, calcium and phosphorus were determined according to A.O.A.C. (1980) methods. Fat content was determined using Foss-Let apparatus Model 15320. Backman amino acid analyzer Model 120 B was used for determining 15 amino acids as described by Spackman et al. (1958). The amino acid methionine was estimated following the microbiological method, Barton and Wright (1952) The rapid method for available lysine determination was applied using the Dye-Binding procedure described by Hurrel et al.(1979). Estimation was performed on the Prometer apparatus Model 14914.

Chick bioassay:

The chick bioassay conducted to evaluate the protein quality of the DCSL was that described by Woodham and Deans (1975).

Chicks and management: Two hundred (one-day old) Hubbard broiler chicks were reared in an electrically heated battary for 2 weeks on a standard broiler diet (22% protein and 3200 Kcal/kg diet). At the fourteenth day one hundred and five chicks were selected for the experiment by discarding lower and larger chicks. Thereafter chicks were allocated over 15 battary compartment, 7 chicks each.

Diets: The experimental chicks were fed on five iso-nitrogenous iso-caloric diets (Table, 1). They were adjusted at 3000 Kcal/kg diet and 18% protein (NX6.25). Diets were formulated mainly from a mixture of corn and wheat bran to provide 6 protein units. Soybean meal in the control diet (diet A) and the DCSL in diet B,C,D and E were incorporated to provide 12 protein units. Diet C,D and E were supplemented by lysine, methionine and lysine + methionine, respectively.

Each diet was fed ad. lib. to 3random groups of chicks for 24 hours of artificiallight. Weight gain and feed consumption were measured at the end of the experimental period (14-28 days) and the total protein efficiency (TPE) was calculated.

Statistical methods: Data were analyzed statistically according to the method described by Snedecor and Cochran(1973). Differences between means were determined by Duncan's multiple range test (1955).

Table (1)

The percentage composition of the experimental diets

Ingredients	Diets				
	A	B	C	D	E
Yellow maize	61.36	61.36	61.36	61.36	61.36
Wheat bran	6.00	6.00	6.00	6.00	6.00
Soybean meal	27.27	-	-	-	-
DCSL *	-	27.58	27.58	27.58	27.58
Vit. & Min. mixture **	0.30	0.30	0.30	0.30	0.30
Steamed Bone meal	1.50	1.50	1.50	1.50	1.50
Na cl	0.30	0.30	0.30	0.30	0.30
Corn oil	2.30	0.50	0.90	0.66	1.00
Sucrose	0.87	2.46	1.66	2.10	1.36
L. lysine	-	-	0.40	-	0.4
DL Methionine	-	-	-	0.20	0.20
Chemical analysis:					
Crude protein (NX 6.25)	18.1	17.9	17.6	17.4	17.8
ME, K cal/kg diet (calculated)	3000	3000	3000	3000	3000
Lysine (calculated)	0.99	0.58	0.98	0.58	0.98
Methionine (calculated)	0.41	0.2	0.2	0.4	0.40

* ME, K cal/kg is 2600, Patrick & Schaible(1980)

** Each kg of the mixture contains:-

Vit. A, 90.000 IU	Vit. B_{12}, 1200 mg	Mn, 1200 mg
Vit. D_3, 120.000 IU	Folic acid, 60 mg	I, 60 mg
Vit. E, 1200 IU	Choline chloride, 3000 mg	Zn 4200 mg
Vit. K_3, 150 mg		Fe, 240 mg
Vit. B_1, 1200 mg		Cu, 300 mg
Vit. B_2, 360 mg		Co, 18 mg
Vit. B_6, 120 mg		Ca, 250,000 mg
Nicotinic acid, 1800 mg		P, 20.000 mg
Pantothinate, 400 mg		N, 20.000 mg
		Cl, 20.000 mg
		BHT, 5000 mg

RESULTS AND DISCUSSION

Proximate analysis:

Proximate analysis of the representative sample of DCSL (table, 2)showed that it could be considered as a balanced ingredient which contained 43.5% crude protein and 33.63 NFE. Ash content was 8.54% which is relatively rich in calcium and phosphorus. The obtained analysis makes DCSL seems to be equivalent to such ingredients used in poultry feeds, i.e. soybean meal.

Table (2): Proximate analysis of DCSL and Soybean meal (SBM)

Sample	Moisture %	Crude protein %	Fat %	Ash %	Fibre %	NFE %	Ca %	P %
DCSL	9.83	43.5	2.6	8.54	1.90	33.63	1.18	0.98
SBM	9.55	44.0	1.25	7.08	4.53	33.59	0.25	0.60

El-Alaily (1974) mixed corn steep liquor with corn hulls, the final product contained about 21.21% protein and 52.6% NFE. Ash content (15.56%)was noticebly high which could be a limiting factor for use in poulty feed. Patrick and Schaible (1980) reported 31% crude protein and 1170 Kcal/pound as ME for a product namely corn dry-steep water concentrate.

Amino acid composition:

The amino acid composition (g/100 g protein) of the DCSL with that of SBM are set out in table (3). Data shows that DCSL is considerably lowere than SBM in the amino acids, Lysine, arginine, phenylalanine + tyrosine, histidine, isoleusine, leucine, methionine, aspartic acid and glutamic acid. Whereas, DCSL and SBM are nearly the same in the amino acids serine + glycine and valine. On the other hand, threonine proline and alanine are considerabley higher in DCSL than SBM.

Table (3)

Amino acid composition (g/100g protein)

of the DCSL and soya bean meal (SBM)* as

compared with the amino acids requirement of broiler chicks**

Amino acids	DCSL	SBM	Amino acid requirement
Arginine	4.23	7.11	6.26
Glycine	4.72	4.16	-
Serine	4.38	4.98	-
Glycine + serine	9.10	9.14	5.00
Histidine	2.45	3.38	3.00
Iso-leucine	3.12	4.51	3.48
Leucine	5.06	7.49	5.87
Lysine	3.27	5.99	5.22
Tyrosine	2.29	3.02	-
Phenyl alanine	2.55	5.22	3.13
Tyrosine + Phenyl-alanine	4.34	8.24	5.83
Threonine	4.28	3.72	3.48
Methionine	0.67	1.49	2.17
Valine	4.98	5.02	3.56
Aspartic acid	4.23	10.77	*** N
Glutamic acid	11.23	17.87	N
Proline	8.89	4.96	N
Alanine	6.92	4.22	N
Available lysine	1.09	-	-
Chemical score	30	69	-

* Eggum et al (1983)

** National Research Council (1984)

*** Non Essential for poultry.

In the present study the quality of the protein was estimated from its amino acid composition as compared with reference pattern of amino acids (Mitchel and Block, 1946). In practice, the amino acid requirement of the chicks has been taken as a suggested reference (El-Bouchy 1980), Since the material is evaluated for use in poultry feeds.

Comparision of the amino acid composition of the DCSL with the amino acid requirement of broiler chicks (NRC, 1984) revealed that DCSL satisfied the requirement from the amino acids glycine + serine, threonine and valine and about 88% from arginine. Whereas, isoleucine, leucine, and phenylalanine + tyrosine can satisfy, as an average, about 85% of the requirement.

The first limiting amino acid in the DCSL was found to be methionine followed by lysine. Chemical score was 31 and 68, respectively.

Although chemical score is valuable tool for screening the protein, it has one real fault: it assumes that all amino acids are 100% available, Satterelee et al (1979).

Estimation of available lysine using the Dye-Binding procedure in the studied sample showed that lysine is drastically affected by heat treatment. About 33% of the total lysine is only available. Chemical score was re-calculated taking into consideration the proportion of lysine which weill be available. Consequently available lysine was found to be the first limiting amino acid. On this basis chemical score decreased to 21, showing the actual chemical score.

Few studies were conducted on corn steep liquor as a source of protein. El-Alaily (1974) showed that there are markedly lesser amounts of most amino acids than cotton seed meal. However, valine seems to exist in reasonable amounts.

Chick bioassay:

The main results of the biological experiment conducted to evaluate the protein quality of DCSL are presented in table (4).

Feed intake: Feed intake of chicks fed on the control diet(A) was 5900 g/group. Statistical analysis showed that it was significantly higher ($P<0.01$)than feed intake of chicks fed on other diets containing DCSL.Lower feed intake of chicks fed on diets B and D can be attributed to that dietary lysine level of these diets is lower than chick requirments. Lysine supplmented diets: C and E could be deficient in lysine due to impaired availability of lysine in the DCSL. Fisher et al.(1960) showed that chicks given lysine deficient diets tend to reduce feed intake and consequently aggravate the deficiency. However,feed intake of chicks given diet C or E increased significantly ($P<0.01$) as compared with diets B or D. Diet C which was deficient in methionine showed higher feed intake as compared with diet D which was deficient in lysine. Carew and Hill (1961) reported that chicks offered diets deficient in methionine tended to over-eat. Difference in response of feed intake between lysine and methionine is possibly due to differing rols in metabolism.

Weight gain: Chicks fed on the control diet (A)gained 2813 g/group, whereas chicks fed on diet (B)which contained the DCSL gained 1020 g/group. Statistical analysis showed that there are significant differences ($P<0.01$) between diet A and other experimental diets. Supplementing diet B with Lysine (diet C) increased significantly ($P<0.01$)body weight gain from 1020 to 1782 g/group, However supplementation with methionine (diet D) did not show any significant improvement. On the other hand body weight gain of chicks fed on diet E which was supplemented with both lysine and methionine was significantly ($P<0.05$) higher than that of diet C.

Total protein efficiency (TPE): TPE values reflecting chick response to different experimental diets varied significantly. Diet A gave 2.64 as TPE, this value decreased significantly ($P<0.01$) when chicks were fed diet B. Supplementation of diet B with lysine (diet C)or lysine + methionine (diet E)sustained chick growth. TPE values increased significantly ($P<0.01$)from 1.49 to 2.23and 2.44, respectively. Concerning diet D which was supplemented with only methionine, it was significantly($P<0.01$) lower than diet C and E. On the other hand it was highly significant as compared with diet B.

Table (4)

Broiler chick response to different experimental diets

Diet No	Group starting wt. gm.	Group finishing wt. gm.	Body weight gain gm	Feed eaten gm	Crude protein %	Crude protein eaten gm	TFE
	1765	4540	2775	5850		1059	2.62
	1770	4600	2830	5900		1062	2.66
(A)	1775	4610	2835	5950	18.1	1071	2.64
	1770	4583	2813^{a}	5900^{a}		1064	2.64^{a}
	1770	2780	1010	3900		698	1.45
	1780	2840	1060	3880		694	1.53
(B)	1780	2750	990	3700	17.9	662	1.49
	1770	2790	1020^{b}	3826^{b}		685	1.49^{b}
	1770	3600	1830	4700		827	2.21
	1765	3550	1785	4550		801	2.23
(C)	1770	3500	1730	4400	17.6	774	2.24
	1768	3550	1782^{c}	4550^{c}		800	2.23^{c}
	1760	2800	1040	3400		592	1.76
	1770	2880	1110	3800		661	1.68
(D)	1770	2910	1140	3750	17.4	652	1.75
	1767	2863	1096^{b}	3650^{b}		635	1.73^{d}
	1770	3660	1890	4350		774	2.44
	1765	3600	1835	4300		765	2.40
(E)	1760	3700	1940	4400	17.8	783	2.48
	1765	3653	1888^{e}	4350^{c}		774	2.44^{e}

Means with different subcripts vertically are significantly different by the Duncan's multiple rang tests.

It could be concluded from the present work that there is good agreement between chemical and biological evaluation of DCSL. Results revealed that the protein quality of this material is relatively low as compared with such ingredients, i.e. soybean meal. However, El-Alaily (1974) found that the dried corn steep water is similar in protein quality to cotton seed meal, other wise it was poor in the amino acids. Camp et al (1957) and Creger et al (1962)reported that CSL solubles may contain unidentified growth factor (s), which may explain good chick response in feeding experiments. Also, Hazen et al(1972) demonstrated that corn dry steep liquor in corn-soy diets improved egg quality.

Considering the disadvantage of DCSL being limiting in lysine and methionine, supplementation with these amino acids improved relatively its protein quality. The extent of improvement was not satisfactory as compared with soybean meal.

Also, attention has to be paid for available lysine in lysine supplementation to obtain the expected increase in growth. Besides, it could be better to reevaluate the process of concentrating and drying of the steep water in order to protect lysine from being enfluenced by the applied heat.

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نوعية بروتين منقوع مياه الذرة المجففة

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المعمل المركزى لتحليل المواد الغذائية ـ مركز البحوث الزراعية
وزارة الزراعـــــة

الملخـــص

اختير منقوع مياه الذرة المجففة (أميتوفيد) لارتفاعه فـى نسبة البروتين الخام (٤٣،٥ ٪) لدراسة امكانية الاستفادة منه فى علائق الدواجن وقد استخدمت الطريقة الكيميائية بتقدير الاحمـاض الأمينية والطريقة البيولوجية باستخدام كتاكيت التسمين هيرد فـى تقييم بروتين المادة المختبرة .

وقد اتضح من تقدير الأحماض الامينية ومقارنتها بالاحتياجات اللازمة لكتاكيت التسمين أن الحمض الأمينى مثيونين هو الحامض الأمينى المحدد للنمو وكانت درجة البروتين ٣٠ . وبتقدير الليسين المتـاح وجد أنه يمثل ٣٣ ٪ من الكمية الكلية لليسين . وباعادة حسـاب درجة البروتين على هذا الأساس يتضح أن الحامض الأمينى المحدد للنمو هو الليسين واصبحت درجة البروتين ٢١ .

ومن التجارب البيولوجية وجد أن الكفاءة الكلية للبروتيـن للعليقة المحتوية على كسب فول الصويا (كنترول) ٢،٦٤ بينمـا للعليقة المحتوية على منقوع مياه الذرة المجففة ١،٤٩ وباضافـة الاحماض الامينية المحددة للنمو (الليسين + المثيونين) الى العليقة المحتوية على منقوع مياه الذرة وجد تحسن واضح فى الكفاءة الكليـة للبروتين .

ومن هذه النتائج اتضح أن هناك اتفاق بين الطريقة الكيميائية والبيولوجية على انخفاض القيمة الغذائية لبروتين منقوع ميـاه الذرة الا أنه يمكن تحسين نوعية البروتين نسبيا باضافة الاحمـاض الأمينية المحددة للنمو .

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