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Composition and nutritive value of chickpea

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SUMMARY - The chemical composition of some samples of chickpea was studied and compared with published values. A critical evaluation of the different nutrients is presented, in particular the aminoacid content. These parameters are analysed in terms of animal requirements and the chickpea has been evaluated as a protein and an energy source of diets for non-ruminant and ruminant animals. The importance and the nutritive value of the chickpea straw is also mentioned.

RESUME - "Composition et valeur nutritive du pois chiche". Des échantillons de 8 variétés de pois chiche ont été caractérisées chimiquement et leurs résultats comparés avec les valeurs publiées dans les Tables de Composition Internationales. Ces protéagineux sont présentés en ce qui concerne leurs différents nutriments en particulier leurs acides aminés. Les résultats ont été analysés en fonction des besoins des animaux et le pois chiche a été caractérisé comme une source de protéines et d'énergie pour les rations des monogastriques et des ruminants. L'importance et la valeur nutritive de la paille de pois chiche est aussi mentionnée.

Introduction

It has been demonstrated that legume protein is the natural protein suitable to complement that present in cereal grains. When both are ingested, in appropriate ratio, the protein quality is higher than that of the individual components (Bressani, 1975).

In general, legume grains comprise an important part of the human diet in developing countries in tropical and subtropical areas, where their nutritional contribution is of paramount importance, as a large segment of the populations in these areas have limited access to food of animal origin.

This has been the case with chickpea which has seldom been used in animal nutrition. However if the economics of its production were improved, either by increasing the yield or by the introduction of mechanization of the crop, the chickpea can then be a good alternative to the imported protein sources in animal feed.

It is, however, necessary to know its nutritive value when included in animal diets.

Following a contact with the research colleagues (Eng. Manuel T. Barradas and Eng. M. Tavares de Sousa) working in Estaçao Nacional de Melhoramento de Plantas, Elvas, Portugal, samples of different varieties of chickpea were analysed for their chemical constituents in the Breed-

Table 1. List of the varieties used in the studies.

Code	Name	Origin
Var. A	PCH 70	Morocco
Var. B	ICC 6 304	USSR
Var. C	ILC 482	Turkey
Var. D	FLIP 83 15C	ICARDA
Var. E	FLIP 82 186C	ICARDA
Var. F	FLIP 82 258C	ICARDA
Var. G	FLIP 83 41C	ICARDA

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ing and Agronomic Programme of AGRIMED. The genotypes studied and the code used for them in the subsequent text are given in Table 1.

The composition and nutritive value of these varieties with some considerations regarding their potential capacity of substituting traditional feedstuffs in animal diets are presented in the section that follows.

Chemical Composition

From Table 2 it is evident the high level of starch content (45-54% DM) and the amount of soluble carbohydrate (2-9% DM) indicates that chickpea is an important source of available energy. In addition it can be seen that fibre content is not too high (3-8% DM) with most of this fibre content belonging to the NDF fraction (13- 20% DM) rather than to the ADF (5-13% DM) or to the ADL ones (0.1 - 0.8% DM), meaning that it is highly degradable at least for ruminants.

Table 2. Chemical composition of some selected chickpea genotypes.

Genotype	DM %	OM	SI (%DM)	EE (%DM)	CF (%DM)	NDF (%DM)	ADF (%DM)	ADL (%DM)	Sugar (%DM)	Starch (%DM)
Var. A	88.4	84.8	0.19	5.1	5.4	16.3	10.1	0.63	2.6	50.3
Var. B	88.4	84.9	0.15	4.3	8.0	20.1	12.8	0.76	2.3	44.5
Var. C	87.5	85.1	0.11	6.3	3.9	12.7	5.5	0.42	5.5	50.4
Var. D	88.6	85.6	0.19	5.8	3.6	14.6	5.8	0.63	6.3	49.1
Var. E	87.5	84.2	0.16	5.5	3.8	16.0	5.7	0.42	8.7	45.9
Var. F	87.7	84.3	0.27	6.3	3.1	14.6	6.4	0.14	7.3	54.2
Var. G	88.1	84.5	0.24	5.6	3.7	15.8	5.9	0.10	7.5	49.8
Var. H	89.2	86.1	0.18	6.4	3.0	13.0	4.8	0.31	6.4	49.9

Comparing these results with the values of other legume grains tested at Estaçao Zootecnica Nacional, Portugal, it appears that chickpea has a crude fiber content close to that of pea (6.4% DM) or faba bean (8.3% DM) but much lower than that of *Lupinus albus* (11.9% DM) or *Lupinus luteus* (17.8% DM).

The high fat content (4-6% DM) is a good contribution for non-ruminant energy fraction and its level does not represent a limiting factor in ruminant nutrition, specially for the adequate ecological conditions of the rumen bacteria.

These varieties of chickpea were nearly free from cyanidric acid. The level of tannins varied from 78 (var. A) to 181 mg/100 g DM (var. D). The impact of tannins on the nutritive value can be important, depending not only on their level but also on the form they occur (i.e. condensed or free tannins). Only further analysis and/or animal trials would clarify this effect.

In Table 3 the data show that the content of crude protein is ranging from 18 to 24% DM, which compares well with other protein sources analysed at the EZN laboratories: values close to faba bean *major* (26% DM), pea (21% DM) and *Lupinus albus* (24% DM) but lower than *Lupinus albus* var. 931-S (34.4%), faba bean *minor* (27%), etc.

Table 3. Protein composition of some selected chickpea genotypes.

Genotype	Crude protein (%DM)	Amino acids[a]				
		Arg.	Cyst.	Lys.	Meth.	Trypt.
Var. A	22.6	4.36	4.18	10.30	1.33	1.22
Var. B	24.0	6.24	3.51	6.62	1.36	1.02
Var. C	20.0	7.03	4.32	8.51	1.36	1.27
Var. D	20.5	6.91	5.02	8.29	1.55	1.46
Var. E	22.1	5.92	4.68	8.30	1.40	1.45
Var. F	20.7	6.02	4.67	8.78	1.53	1.39
Var. G	21.3	7.71	4.39	7.93	1.52	1.24
Var. H	18.2	7.98	4.06	9.33	1.64	1.25

[a]/ g/100 g C.P.

Looking at aminoacids composition (g/100 g CP; Table 3), it is clear that the arginine content varies from 4.4 to 8.0 which compares well with *Lathyrus cicera* (6.8), *Lathyrus ochrus* (8.0) and *Vicia sativa* (6.6) and is higher than casein (3.9) which is usually used as a reference. The cystine content (3.5 - 5.0) is much higher than in the other legumes such as *Lathyrus cicera* (1.4), *Lathyrus ochrus* (1.1) and *Vicia sativa* (1.1) and casein (0.4) but close to that of *Lupinus albus (4.1) or Lupinus luteus* (5.9). A similar observation can be made with respect to lysine content that varies from 6.6 to 10.3 and also with respect to methionine content (1.3 to 1.6) which are well above the average of the other legumes. However tryptophane content (1.02 to 1.46) seems to be closer to the values observed with *Lathyrus cicera* (1.04), faba bean *major (1.05), Lupinus albus* (0.96) and higher than *Lathyrus ochrus* (0.28).

Nutritive parameters

It was not possible with such small amount of samples to perform animal tests, however, some indirect measurements were made in particular for the prediction of nutritive value for ruminants.

In fact, the in vitro DM and OM digestibilities (Table 4) showed values quite high (80-88%) that can be compared to the ones observed with most of the cereals used in animal diets (barley, maize or even oat).

Another technique (gas test) was applied that reflects the capacity of feedstuff to cover the energy requirements of the rumen bacteria. Again (Table 4), the several samples of chickpea showed a behaviour where most of the energy was available in 24 hours of incubation (Fig. 1) meaning a very easy fermentable substrate.

Table 4. Nutritive parameters of some selected genotypes.

Genotypes	In vitro dig (%)		Gas test (ml/g, 24h)	Metabolizable energy (MJ/kg)		
	DM	OM		Poultry[a]	Pigs[b]	Rumin.[c]
Var. A	81.1	81.0	164	12.4	13.3	11.9
Var. B	79.9	79.7	128	11.4	13.3	11.8
Var. C	89.0	88.2	172	12.6	13.2	13.2
Var. D	87.2	87.6	176	12.5	13.3	12.9
Var. E	88.4	88.4	188	12.3	13.2	13.1
Var. F	88.2	88.5	188	13.4	13.2	13.1
Var. G	87.7	87.0	154	12.7	13.2	13.0
Var. H	87.2	88.8	166	12.6	13.4	12.9

[a]/ Based on ME (MJ/kg) = 0.1551 CP + 0.3431 EE + 0.1669 starch + 0.1301 sugar (JO CEE, 1986).
[b]/ Based on ME = 0.96 DE (INRA, 1984).
[c]/ Based on ME = 0.16 DMOD (MAFF, 1975).

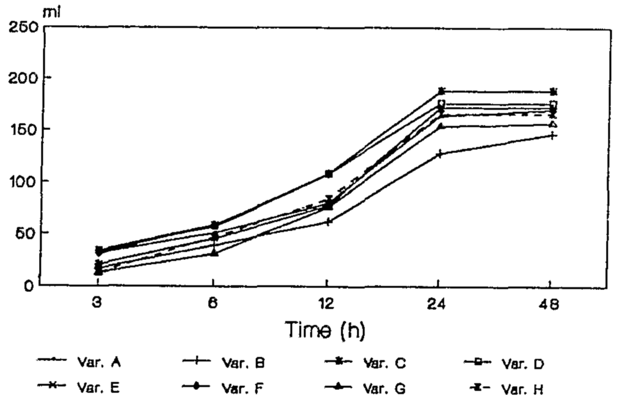

Fig. 1. Time course of gas production in gas test of chickpea genotypes using rumen bacteria.

These observations show that chickpea is also a very good energy substrate for ruminant diets and can be included as component of concentrates. It looks that not only starch, fat and soluble carbohydrate are available but also the fibre fraction, in particular, the NDF fraction will promote a good fermentation within the rumen.

The data in Table 4 on the predicted metabolizable energy values indicates a very good feedstuff as energy supplier, for both non-ruminants and ruminants.

However the main nutritive possibility of chickpea seems to be as protein supplement, in particular for non-ruminant animals (pigs and poultry) and to evaluate this, reference tables are presented, one for pigs (Table 5) and another for poultry (Table 6). Chickpea can also be used as component of concentrate diets for ruminants and therefore a table of requirements for ruminants is also presented (Table 7).

Table 5. Amino acids (g/100g) and metabolizable energy (MJ/kg) requirements for pigs.

Amino acids	Piglets		Pigs	
	1st phase	2nd phase	Growing	Finishing
Arginine	0.36	0.32	0.25	0.20
Lysine	1.40	1.10	0.80	0.70
Meth. + Cyst.	1.80	0.65	0.50	0.42
Tryptophane	0.25	0.20	0.15	0.13
Met. Energy	14.30	14.30	13.50	13.50

Adapted from INRA (1984).

Table 6. Amino acids requirements for poultry.

Amino acids	Chickens[a] g/100g CP	Chickens (g/100g)[b] ME (MJ/kg)			
		12.1	12.4	12.6	13.4
Arginine	5.0	1.03	1.05	1.06	1.14
Cystine	1.6	–	–	–	–
Lysine	5.0	0.98	1.00	1.02	1.08
Methionine	2.0	0.43	0.44	0.44	0.47
Treyptophane	0.8	0.19	0.20	0.20	0.22

[a]/ Based on starting and growing chickens
[b]/ Based on growing chickens (3rd week).
Adapted from Feedstuffs (1986); INRA (1984).

Table 7. Protein and metabolizable energy requirements for ruminants.

	Cattle		Sheep	
	Beef[a]	Dairy[b]	Growth[c]	Lactat.[d]
CP (g/kg DM)	100	112	100	156
ME (MJ/day)	45	99	5.6	19.9

a/ Based on 400 kg live weight; q (metabolizability) = 0.7; maintenance.
b/ Based on Friesian; 600 kg live weight; q = 0.7; milk yield = 10 kg/day; maintenance.
c/ Based on castrated lambs; 40 kg live weight; q = 0.7; maintenance.
d/ Based on 40 kg live weight; q = 0.7; milk yield = 2.0 kg/day; maintenance.
Adapted from ARC (1980).

Table 8. Chickpea requirements as % of total diet.

Amino acids	Piglets		Pigs	
	1st phase	2nd phase	Growing	Finishing
Arginine	28.6	25.4	19.8	15.9
Lysine	92.1	72.4	52.6	46.1
Meth. + Cyst.	74.1	60.2	46.3	38.9
Tryptophane	–	83.7	62.8	54.4

From the comparison between composition of chickpea and nutrient requirements it is possible to say for pigs (Table 8) that tryptophane is the limiting aminoacids followed by lysine and then the sulphur aminoacids. However (with the exception of tryptophane) this limitation is not critical and chickpea can be the main constituent of the protein fraction of no-ruminant diets.

Besides, there is no apparent anti-nutritive factors affecting the inclusion of chickpea in pig diets and the role and effect of the tannin contents needs yet to be tested.

Regarding poultry, methionine is the first limiting aminoacid followed by arginine and lysine. Here the problem is similar and a methionine rich supplement or synthetic methionine should be added to the chickpea. Arginine is covered when 78% of chickpea is added and lysine would be adequate with an inclusion level of 68% of chickpea in the ration.

Amongst the ruminants it would be all right for beef cattle in terms of the crude protein, when chickpea is 47% of diet and the necessary levels of chickpea incorporation for dairy cattle, growing lambs and lactating ewes (Table 7) would be respectively 53, 47 and 74%.

Chickpea straw

The straw residues left after harvesting of chickpea represents a material with an interesting nutritive value compared with similar straws from other crops (Table 9).

Table 9. Composition and nutritive value of straws.

Crops	DM	CP	CF	Digestibility (%)				Nut. value (MJ/kg)		
	(%)	(%DM)	(%DM)	OM	CP	CF	EN	UFL	UFV	ME
Sunflower	95	2	58	50	–	43	46	0.53	0.42	6.9
Oat	87	3	42	48	–	55	44	0.49	0.38	6.4
Barley	86	4	41	44	–	52	42	0.44	0.34	6.0
Chickpea	87	10	37	62	64	41	58	0.66	0.57	8.3

Adapted from Options Medit. (1981).

Organic matter digestibility is quite high (62%) as well as the energy digestibility (58%) which gives the product a metabolizable energy of 8.3 MJ/kg. In nutritive terms, this means a forage able to cover the maintenance requirements and even support small to medium levels of production for beef cattle or lamb producing sheep.

Conclusion

From the data on the composition of chickpea samples analysed in this study the values compare well with those mentioned in International Feed Composition Tables (Feedstuff, 1986). As a potential feedstuff these samples showed a high level of crude protein and starch, and a low fibre content. The aminoacids profile adequately adjusts to the pig and the poultry requirements with the exceptions for tryptophane and methionine, respectively. Chickpea has a high nutritive value in ruminant nutrition, specially as a concentrate component (energy and protein fractions of the diet). There is no apparent anti-nutritive factors other than tannins whose effect must be further tested.

The chickpea straw is a very good feedstuff compared with other cereal straws.

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