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Study on chemical composition, degradation and protein characterization of oilseeds cakes available in Sudan market

I. Y. Turki and Atcham. A. A

College of Animal Production Science and Technology, Sudan University of Science and Technology

Abstract

The study was conducted to determine the rumen degradability of dry matter (DM) and crude protein (CP) degradation of groundnut cake (GNC), cottonseed cake (CSC) and sunflower cake (SFC). In situ trial was employed using three fistulated bulls. Three nylon bags were used for each feed and each time of incubation per sheep. The bags were incubated in the rumen of each animal for 6, 12, 24, 26 or 48 hrs. Significant ($P<0.05$) differences were obtained among the oilseeds for DM and CP degradability according to feed samples and incubation times. Dry matter and crude protein disappearance percentage of GNC was found higher than those of the other cakes at different incubation time. SFC had the lowest DM and CP disappearing percentage than CSC. Software technique (protparam program) was used to analyze (DNA) of each experimental oilseed cakes. The result identifies the physiochemical properties and determined molecular weight and amino acids composition of oilseed cakes. Results showed that SFC had higher molecular weight amino acid concentration followed by CSC and GNC, that' why GNC is unstable protein while CSC and SFC are stable proteins.

Keywords: Degradation, Oilseed Cakes, Protein Characterization

Introduction

Sudan is considered a rich country in crops production, crops residues and agro-industrial by-products. Total crops residues in Sudan were estimated to be 14 million tons (Ministry of agriculture, 1993-1994). Protein is a critical nutrient for young growing and fattening animals, being more expensive than other energy feeds (Church, 1977). Protein is complex component of molecular weight which contains carbon, hydrogen, sulphur and in addition some protein contain phosphors and copper (McDonald et al., 1981). Oilseed cakes are industrial by-products after removal great part of oil from seeds and the remaining of extraction of oil (cakes) used in animal feeding. The nylon bag technique is a simple mean of obtaining estimates of potential degradability of supplements and feedstuffs for ruminants. Inclusion of values for fractional clearance of undigested feed residues from the rumen degradability provides the estimates of rate of degradation of the various components of the tested material which more closely approximate true degradability of the material in the rumen (Bhargava and Orskov, 1987). The protein feed ingredients varied in their resistance to degradation in rumen (Nolan and Lerg, 1983). Protein requirements for ruminants are satisfied from microbial protein, synthesized in the rumen from degradable protein (RDP) and from rumen undegradable dietary protein (UDP), which is unaffected by the rumen microorganisms prior to entering the abomasum. Degradation of protein depends on natural of feed, and protein hydrolyzed by rumen micro-organisms as peptides and amino acids or ammonia (McDonald et al., 2002).

Bioinformatics defined as a branch of molecular biology or computer science collecting, organizing (DNA) protein sequence through software technique (Protparam Program) to determine molecular weight, amino acids concentration and estimated half-life (NCBI, 2010). Because large quantities of crops (especially groundnut, sunflower, and cottonseed and sesame seed) are present in Sudan, it is needed to study their rumen degradability characteristics due to possible usage of them as an alternative animal protein. The objectives of this study were to determine the chemical composition, dry matter & crude protein disappearance (%) and effective degradability of some oilseed cakes. Identification and characterization of each protein was determined by using software Protparam programme.

Materials and Methods

The experiment was carried out at College of Veterinary Medicine and Animal Production in Sudan University of Science and Technology. Three fistulated, bulls from local breed (Kenana) at age of 3–3.5 years,

were fitted with rumen cannula as described by (Brown et al., 1986). Samples collection and preparation of all cakes were purchased from Omdurman market (1/2 kg from each feeds).

The nylon bag technique was used in this study to determine the effective degradability and disappearance percentage of dry matter and crude protein. The bags were incubated in the rumen at different periods (6, 12, 24, 36 and 48 hrs). The bags were removed at the end of each incubation period, washed under tap water dried in oven (70^{o}C) overnight and cooled in desiccator and weighed immediately, to determine the dry matter disappearance percentage. Approximate analysis to determine the chemical composition of experimental oilseed cakes was performed according to AOAC (1990). Samples from fresh residuals were taken regularly for dry matter and crude protein calculation**.** Fit curve programme was used to determine the disappearance of crude protein and dry matter and for evaluation of effective degradability of DM and CP estimated at out flow rate K = 0.02, 0.05 and 0.08. Data for all response variables were subjected to analysis of variance (ANOVA) using the SPSS, (2008) and significant differences between treatment means were determined by using Lest Significant Difference (LSD) at P<0.05 according to Gómez and Gomez, (1984). The bioinformatics Software technique (Protparam Programme) was used to examine the molecular weight and amino acids concentration of experiment oilseed cakes.

Results and Discussion

Chemical composition of three oilseed cakes which were Groundnut cake (GNC), cottonseed cake (CSC) and sunflower (SFC) cake are shown in table 1. Dry matter percent and crude protein percent of SFC, CSC and GNC were 96.4-40, 94.6-25.3 and 95.7-27.25 respectively. Results of this analysis are in range of the finding obtained by Yousif and Afaf (1999) who analyzed the oilseed cakes for dry matter and crude protein contents of GNC, CSC and SFC.

Significant differences (P<0.05) were obtained among the oilseeds for DM and CP degradability in term of feed samples and incubation times (Tables 2). After 48 hours, GNC had significantly high (P<0.01) dry matter disappearance percentage. This result was in agreement with the result obtained by Adnan et al. (2010) who investigated the degradability of some oilseed cakes in rumen by using nylon bags technique. They reported that groundnut cake had a highest dry matter disappearance percentage (82.11%) at 48 hours incubation period. This result is also in agreement with another study obtained by Turki (2002). She reported DM disappearance percentage to be 88, 77.7 and 78% for GNC, CSC and SFC respectively. Many factors may affect degradability of DM and CP in the rumen. Variations in degradation values refer to the type of feedstuff, sample preparation, washing procedures, animal, etc. (Nocek and Russell, 1988). In present study the results indicated that GNC had the highest values for dry matter disappearance and effective degradability (Tables 3). Potential degradability (Pd) at out flow rate K = 0.02 were 88.6, 80.5 and 74.6 for GNC CSC and SFC, respectively.

Table 1: Chemical composition (%) of experimental oilseed cakes

Ingredients	SFC	C.S.C	GNC
Crude protein %	40	25.3	27.5
Dry matter %	96.4	94.6	95.7
Ash %	5.22	4.91	4.1
Moisture %	3.6	5.4	4.3
Molecular weight (Mole)	23834.6	17306.5	16135.5
Amino acids (Number)	207	159	141

SFC= Sunflower cakes; CSC= Cottonseed cake; GNC= Groundnut cake

Crude protein disappearance percentage of the experimental oilseed cakes are presented in Table 4. Sunflower cake signed a lowest CP disappearance percentage (78.31), while cottonseed cake and groundnut cake recorded 88.64 and 97.68%, respectively at incubated period of 48 hrs. This result agrees with that obtained by Adnan et al. (2010) who reported that the crude protein disappearance percentage from the rumen for GNC was slightly (P<0.05) higher than other oilseed cakes. Similar result was obtained by Turki (2002) who recorded that GNC

Table 2: Dry matter disappearance (%) of three oilseed cakes

Incubation / hrs	GNC	CSC	SFC	SE	Sig
0	51.27±3.43^{a}	43±6.13^{b}	38.08±4.11^{b}	1.55	NS
6	60.35±4.74^{a}	48.23±6.56^{b}	44.6±4.57^{b}	1.46	NS
12	70.7±4.50^{a}	60±8.38 ^{b}	52.1±6.05^{b}	1.29	*
24	78.13±3.95^{a}	68.6±8.31^{b}	62.01±4.61^{b}	1.20	*
36	86.13±4.11^{a}	76.6±4.21^{b}	69.11±6.84^{b}	1.18	**
48	94.4±2.31^{a}	80.2±3.28^{b}	78.2±4.77^{b}	1.02	**

SFC= Sunflower cakes; CSC= Cottonseed cake; GNC= Groundnut cake; $^{a-b}$Means within a row with similar superscript are not significantly different (p>0.05); SE: Standard error of the means SFC= Sunflower cakes; CSC= Cottonseed cake; GNC= Groundnut cake; *: significant

Table 3: Dry matter effective degradability of three oilseed cakes

Fitted values	GNC	CSC	SFC	SE	significant
a	53.9	42	37.5	2.13	NS
b	42	47.9	65.9	2.24	NS
C	0.13	0.32	0.21	2.4	NS
Pd	92.9[a]	90.0 [ab]	89.0 [b]	1.6	*
Ed (0.02)	88.6 [a]	80.5 [b]	74.6 [b]	1.82	*
Ed (0.05)	72.7 [a]	67.6 [b]	65.7 [b]	1.45	*
Ed (0.08)	67.5[a]	64.6 [b]	63.6 [b]	1.67	*

SFC= Sunflower cakes; CSC= Cottonseed cake; GNC= Groundnut cake; a-b: Means within a row with similar superscript are not significantly different (p>0.05); SE: Standard error of the means; Ed: Effective degradability; *: significant

Table 4: Crude protein disappearance (%) of experimental oilseed cakes

Incubation (hrs)	GNC	CSC	SFC	SE	Significant
0	60.24±7.06	59.259±.15	57.10±6.78	1.56	NS
6	78.9±8.45	70.05±6.67	71.14±6.31	1.46	NS
12	87.05±3.79[a]	85.14±5.79[b]	83.9±8.53[b]	1.29	*
24	89.28±2.84[a]	86.40±4.43[b]	85.79±7.20[b]	1.20	*
36	93.88±2.71[a]	87.36±2.15[b]	87.31±3.89[b]	1.18	**
48	97.68±1.43[a]	88.64±3.96[b]	78.31±3.96[b]	1.01	**

SFC= Sunflower cakes; CSC= Cottonseed cake; GNC= Groundnut cake; a-b: Means within a row with similar superscript are not significantly different (p>0.05); SE: Standard error of the means; *: significant

Table 5: Crude protein effective degradability of three oilseed cake

Fitted values	GNC	CSC	SFC	SE	Significant
a	53.5	40.4	36.2	2.13	NS
b	42	62.0	52.8	1.24	NS
c	0.16	0.72	0.61	1.64	NS
Pd	97.9[a]	91.0[ab]	90.1[b]	1.67	*
Ed (0.02)	92.9 [a]	90.1 [ab]	78.6[b]	1.82	*
Ed (0.05)	84.1[a]	77.2[b]	70.9[b]	2.45	*
Ed (0.08)	80.6[a]	71.8[b]	70.6[b]	1.67	*

SFC= Sunflower cakes; CSC= Cottonseed cake; GNC= Groundnut cake; a-b: Means within a row with similar superscript are not significantly different (p>0.05); SE: Standard error of the means; Ed: Effective degradability; *: significant

had a highest degradable crude protein value in the rumen.

Crude protein effective degradability from the rumen is shown in Table 5. The results indicated that the different oilseed cakes affected crude protein degradability. At 6hrs incubation period, no significant difference (P>0.05) observed among experimental oilseed cakes.

The result of ProtParam program analysis for GNC, CSC and SFC has been shown in in table 6 and figures 1, 2 and 3. Molecular weight and amino acids concentrations recorded were 23834-207, 17306.5-159 and 16135.5-141 for SFC, GNC and CSC, respectively. The result indicated that the SFC had a higher molecular weight includes higher percentages of alanine, glutamine, leucine and arginine, while it had lower percentages of valine, lysine, threonine, serine and phenylalanine amino acids. The CSC recorded medium molecular weight and amino acids concentrations and signed sub-optimal percentages of threonine, glutamic acid, serine, methionine and leucine, but was low in cysteine, histidine, glutamine, arginine and tryptophan. The GNC had protein of high level in valine, glutamine, leucine, arginine and serine, low in lysine, isoleucine and tyrosine and tryptophan did not detected for GNC. The result of software technique classified groundnut cake as unstable protein while cottonseed cake and sunflower cake classified as stable proteins according to the molecular weight and amino acids concentration which was proved by degradability trial.

Conclusions

Groundnut seeds are most commonly used in Sudan for human consumption and for oil extraction, the residue of which (cakes) is used in animal feeding. The results showed that groundnut cake has the highest degradable protein and lowest by pass protein. Sunflower cake and cottonseed cakes have the highest by pass protein.

Table 6: Amino acids percentage in protein of experimental oilseed cakes

No.	Amino acids	SFC%	No.	C.S.C%	No.	GNC%	No.
1	Alanine	7.2	15	8.8	14	0.7	1
2	Arginine	12.6	26	0.6	1	9.9	14
3	Asparagine	3.9	8	5.7	9	5.0	7
4	Aspartic acid	5.8	12	3.1	5	2.8	4
5	Cysteine	4.8	10	1.3	2	2.1	3
6	Glutamine	11.6	24	1.3	2	3.5	5
7	Glutamic acid	6.8	14	9.4	15	9.2	13
8	Glycine	5.8	12	8.2	13	7.8	11
9	Histidine	1.9	4	1.3	2	2.8	4
10	Isoleucine	2.4	5	6.9	11	2.1	3
11	Leucine	9.7	20	5.0	8	9.9	14
12	Lysine	1.4	3	8.2	13	2.1	3
13	Methionine	2.4	5	1.9	3	8.9	3
14	Phenylalanine	1.9	3	5.0	8	4.3	6
15	Proline	6.8	12	5.7	9	5.0	7
16	Serine	8.2	17	9.4	15	7.8	11
17	Threonine	1.0	2	4.4	7	4.3	6
18	Tryptophan	1.0	2	0.6	1	0	0
19	Tyrosine	2.9	6	5.7	19	1.4	2
20	Valine	1.9	4	7.5	12	10	15
20	Total	100	207	91.8	159	99.6	141

SFC= Sunflower cakes; CSC= Cottonseed cake; GNC= Groundnut cake; No. The number of amino acids in protein; % the percent of amino acid in protein

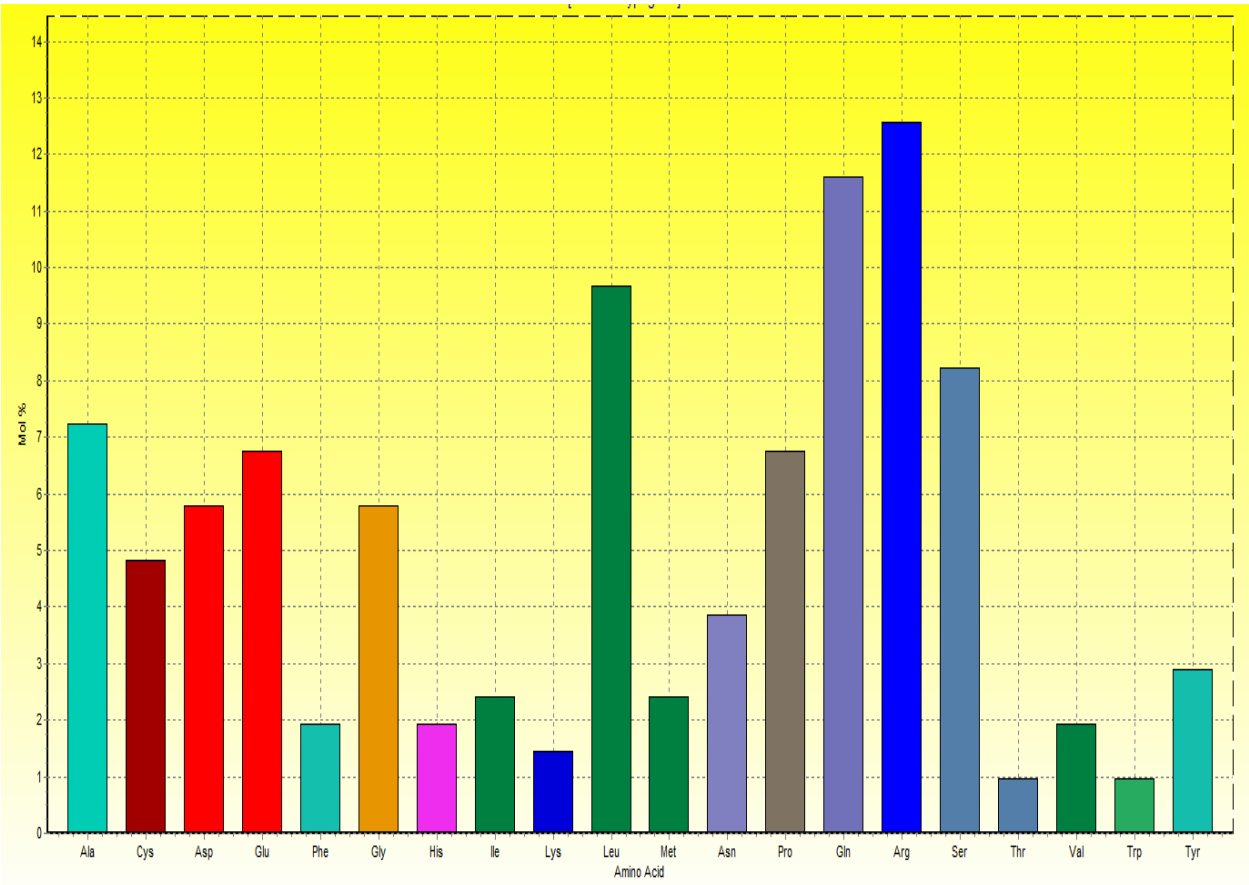

Fig 1: Amino acids composition of groundnut cake

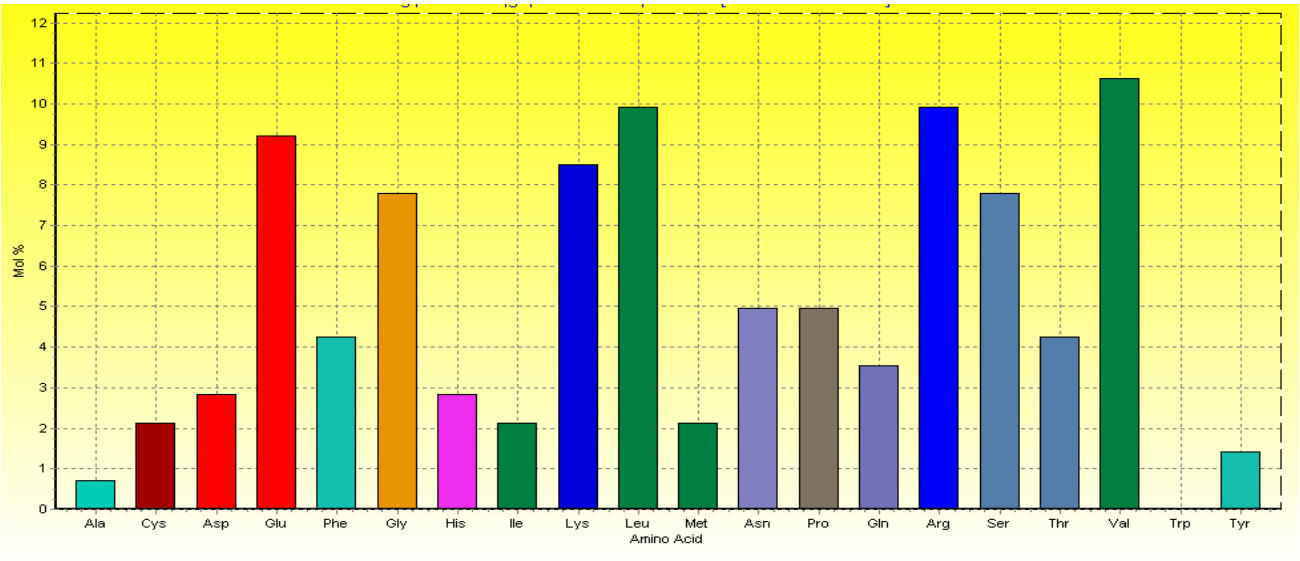

Fig 2: Amino acids composition of sunflower cake

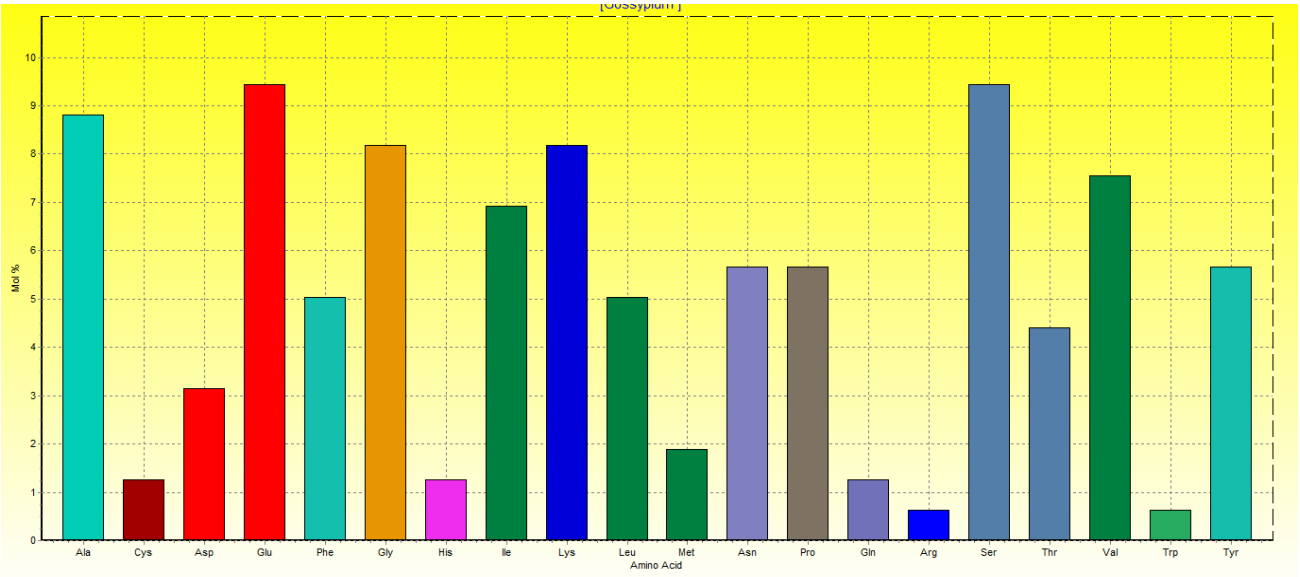

Fig 3: Amino acids composition of cottonseed cake

Recommendations

With the advances in modern livestock production, it is important for farmers to be able to predict as accurately as possible the amount of feed and true feed required to formulate an optimal diet to sustain a desirable level of production. Availability of feed databases for as many locally available feeds as possible are highly desirable due to the fact that most feedstuffs tables portray data derived from different countries. It will make a difference and it will be very successful if we use the biotechnology in our researches as (PCR) polymerase chain reaction to determine the (DNA) sequence to identify and characterize the protein of Sudanese feedstuffs as oilseed cakes and others by-products. That will guide us to the new era of nutritional genomics.

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