Chemical composition of Soybean (*Glycine max,* L) residues (*awara*) obtained from Northeastern Nigeria

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Abstract

Awara is a residue generated from soybeans when producing a native soy-food, and is usually discarded as waste. This study was aimed at determining the nutritional potential of soybeans residues (awara), which is largely available in North-Eastern Nigeria. Thirty (30) fresh samples of awara were randomly collected from ten locations well known for awara production in North-Eastern Nigeria. In each location, three samples were collected. The collected samples were separately labeled, air-dried, milled and then analysed for their nutrient compositions. The results of chemical composition showed significant differences (p<0.05) in crude protein (24.78 – 27.69 %), ether extract (5.80 – 7.57 %), crude fibre (6.56 – 8.47 %), and NFE (28.11 – 33.67 %). Of the minerals studied, only sodium (3.44 – 4.31mg/100g) and potassium (6.07 – 7.52mg/100g) were significantly different (p<0.05). Also, neutral detergent fibre (49.73 – 60.73 %), acid detergent fibre (35.82 –45.40 %) and cellulose (33.90 – 42.43 %) were significantly different (p<0.05) among the fibre fractions determined. The essential amino acids such as arginine, lysine, methionine, phenylalanine and threonine were significantly different (p<0.05) while only alanine (2.48 to 3.45 g/16N) was significantly different (p<0.05) among the non-essential amino acids analysed. Analysis revealed that awara waste contains significant levels of essential nutrients that could be beneficial for animal growth, suggesting it to be considered for feeding trials.

Keywords: *Awara* waste, alternative feed ingredients, nutrients, soy-food

Composition chimique des résidus de soja (*Glycine max* L) (awara) du nord-est du Nigeria

Résumé

L'awara, un résidu issu de la production d'un aliment à base de soja traditionnel, est généralement considéré comme un déchet. Cette étude vise à évaluer le potentiel nutritionnel de l'awara, largement disponible dans le nord-est du Nigeria. Trente (30) échantillons frais d'awara ont été prélevés aléatoirement dans dix sites de production réputés du nord-est du Nigeria, à raison de trois échantillons par site. Après unétiquetage individuel, les échantillons ont été séchés à l'air, broyés et analysés pour leur composition nutritionnelle. L'analyse de la composition chimique a révélé des différences significatives (p<0,05) entre les teneurs en protéines brutes (24,78 - 27,69 %), en extraits éthérés (5,80 - 7,57 %), en fibres brutes (6,56 - 8,47 %) et en extraits sans azote (NFE) (28,11 - 33,67 %). Parmi les minéraux étudiés, seules les teneurs en sodium (3,44 - 4,31 mg/100 g) et en potassium (6,07 - 7,52 mg/100 g) ont présenté des différences statistiquement significatives (p<0,05). De même, des variations significatives (p<0,05) ont été observées parmi les fractions de fibres analysées, notamment les fibres au détergent neutre (49,73 - 60,73 %), les fibres au détergent acide (35,82 - 45,40 %) et la cellulose (33,90 - 42,43 %). L'analyse des acides aminés a révélé des différences significatives (p<0,05) pour les acides aminés essentiels tels que l'arginine, la lysine, la méthionine, la phénylalanine et la thréonine. Parmi les acides aminés non essentiels, seule l'alanine (2,48 à 3,45 g/16 N) a présenté une variation statistiquement *significative ($p<0,05$). Ces analyses indiquent que les résidus d'awara contiennent des niveaux notables de nutriments essentiels pouvant être bénéfiques pour la croissance animale. L'utilisation de l'awara dans l'alimentation animale mérite donc d'être envisagée et explorée plus en détail par des essais d'alimentation.*

Mots-clés : Résidus d'awara, ingrédients alimentaires alternatifs, valeur nutritionnelle, tourteau de soja

Introduction

In Nigeria, several agro by-products such as cobs, cud, hulls, husks, and shells are given little or no economic attention to be re-used (NIAS, 2021; Makinde *et al*., 2022). They are simply thrown away or left to rot. As feed cost continuous to rise due to scarcity and high cost of conventional feed ingredients, it is important to analyze the chemical composition of underutilized agro by-products to determine their nutritional worth. Some agro-related products are not utilized due to insufficient information about their nutritional values, as stated by Agbo and Prah (2014), Duodu *et al.* (2018), Riaz (2011), and Vinayashree and Vasu (1920). Attention was given to *awara* waste in this investigation. *Awara* waste (AW) is generated when producing a cheese-like soy-food called *awara* (in Hausa); is commonly produced in the northern part of Nigeria. It is a major form of utilizing soybean specifically as an alternative to animal protein sources to people for fear of cholesterol (Amusat and Ademola, 2013; Mojisola and Digun-Aweto, 2019). The procedure of making *awara* involves soaking, washing, and grinding using hammer mill. After grinding, water is added to the paste and is sieved. The particles retained in the sieve are described in this study as *awara* waste. It is usually in wet form and can rapidly decompose. The process of generating *awara* waste is similar to the way *okara* is obtained from *tofu* or soy milk production (Fabiyi, 2006; Belewu and Belewu, 2007). The objective of this study was to determine the chemical composition of soybeans (*Glycine max* L) residues (*awara*) obtained from Northeastern Nigeria.

Materials and Methods

Study site

The study area was North-Eastern Nigeria (Figure 1), which comprised of six states namely; Adamawa, Bauchi, Borno, Gombe, Taraba and Yobe. These states cover a vast and extensive region which extends from Lake Chad in the northeast corner to beyond Toro near Jos in the south west corner, and from Jama`re bordering Kano in the northwest corner to Wukari in the southeast (Wikipedia, 2022). It is inhabited by people of different ethnic groups, but the major ethnic groups are Hausa, Fulani and Kanuri. The rainy season usually begins in May or June as moist Atlantic air, known as the monsoon, invades the country. The beginning of the rains is usually marked by the incidence of high winds and heavy but scattered squalls. By May or early June in most years, the rainy season is under way throughout most of the area. The usual peak of the rainy season occurs through most of Northeast Nigeria in July with a dip in precipitation during the month of August. Although rarely completely dry, this August dip in rainfall, which is especially marked in the Northeast, which can be useful agriculturally, because it allows a brief dry period for grain harvesting. From September through November, the northeast trade winds generally bring a season of clear skies, moderate temperatures, and lower humidity for most of the country. From December through February, however, the northeast trade winds blow strongly and often bring with them a load of fine dust from the Sahara. The economy of Nigeria historically was based on agriculture, and about 70% of the workforce is still engaged in farming (largely of a subsistence type). The chief crops in the North-

Eastern Nigeria are rice, sorghum, millet, soybeans, cowpea, sesame, ground nut and vegetable planted under irrigation. In addition, fish, cattle, sheep, goats, horse and camel are raised as livestock. The distribution of vegetation in Northeastern Nigeria is dependent mainly on the climate, which becomes increasingly drier further inland from the coast.

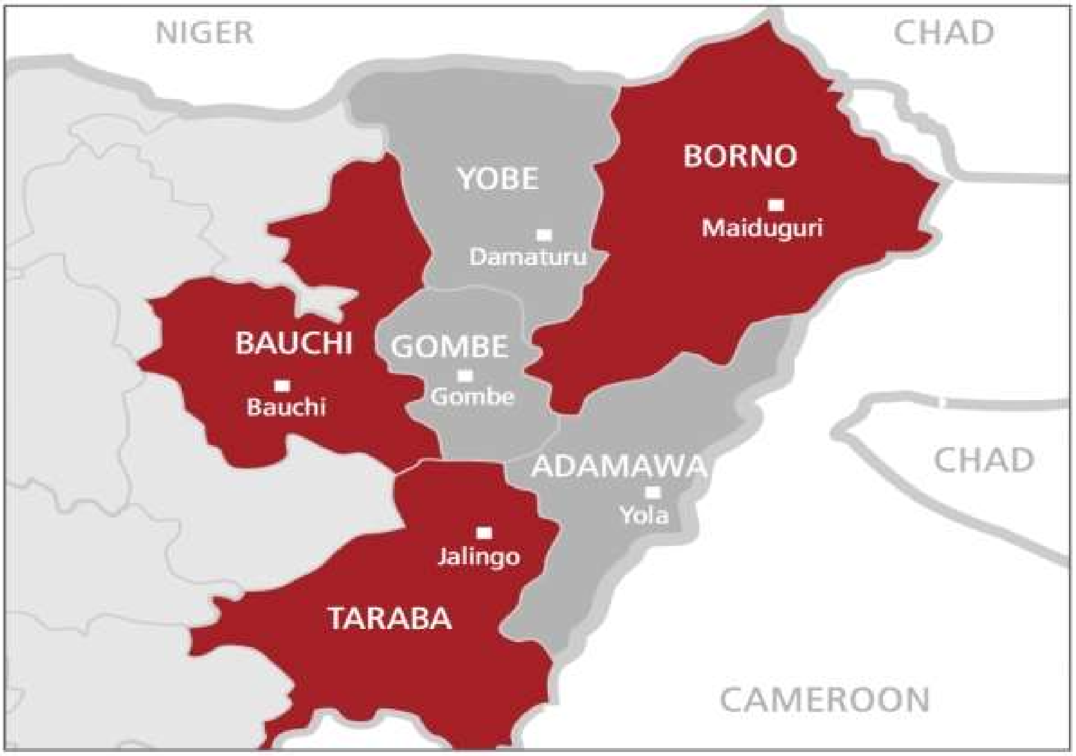

Figure 1: Map of North-eastern, Nigeria showing the study sites

Sample collection and preparation

Two-stage sampling procedure was used to select 30 households (for sample collection) for the study. In the first stage, random sampling technique was used to select ten (10) locations out of twenty (20) locations known for producing large quantity of awara waste in of North-Eastern Nigeria. The selected locations were Biliri, Boi, Damaturu, Das, Gombe, Ibi, Jajimaji, Numan, Sade and Telde. In the second stage, 3 households were selected from each of the selected locations giving a total of 30 households for the study. Before the sample collection, the consent of each household was sought and the objectives of collecting the samples were discussed. Each sample was separately air-dried at 32^0C for 96 hours until completely dried, ground into powder using hammer mill with a sieve of 2 mm and labeled as dried awara residue (DAR). The samples were then stored in air-tight containers until used for laboratory analysis (Makinde *et al*., 2019).

Laboratory analysis

Samples were subjected to laboratory analysis to determine the nutritional compositions according to AOAC (2000) at the Teaching and Research Laboratory, Department of Animal Health and Production, Plateau State College of Agriculture, Garkawa, Plateau State, Nigeria. The parameter analyzed were proximate composition, mineral contents, fibre fractions and amino acid profile. The proximate composition was determined using the method of AOAC (2000). Fibre fractions were determined using the method of

Van Soest *et al*. (1991) as earlier cited by Makinde *et al*. (2022). Sodium and potassium were determined using flame photometry. Phosphorus was determined using vanadomolybdate colorimetry method, while calcium, magnesium, iron, zinc, manganese and copper were determined using atomic absorption spectrometry (AAS). The amino acids were quantitatively measured by the procedure of Benitez (1989) using Applied Biosystems PTH automated amino acid analyzer (Technicon Sequential Multisample Analyzer, TSM, (40405), Model 120A, Version 1.4B, USA). Sample was hydrolyzed for determination of all amino acids except tryptophan in consistent boiling hydrochloric acid for 22 hours under nitrogen flush. The facilities for the determination of tryptophan were not available. Each sample was analysed in triplicate.

Statistical Analysis

Data generated were subjected to Analysis of variance (ANOVA) using the general linear model of statistical analysis system, Version 9.3 (SAS, 2015). Significance was accepted at $P < 0.05$.

Results and Discussion

The proximate composition of DAR obtained from different locations is presented in Table 1. Crude protein content of DAR obtained from Jajimaji was significantly ($p<0.05$) the highest (27.69%) while it was lowest (24.78) in DAR obtained from Telde. Ether extract was significantly ($p<0.05$) higher (7.57%) in DAR obtained from Damaturu while it was lowest (5.80%) in DAR obtained from Telde. Crude fibre was significantly ($p<0.05$) highest (8.39%) in DAR obtained from Biliri while it was lowest (6.56%) in DAR obtained from Das and Damaturu. Nitrogen free extract content was significantly ($p<0.05$) highest (33.67%) in DAR obtained from Telde while it was lowest (28.11%) in DAR obtained from Jajimaji. Moisture and ash were not significantly different ($p>0.05$).

The range of dry matter (88.30- 89.83%) observed in this study was similar to the value of 88% observed for roselle (*Hibiscus sabdariffa* L.) seed cake but lower than other oil seed by-products (NIAS, 2021). The lower dry matter in comparison to other oil seed by-products indicates that DAR has high moisture content. It is therefore necessary to dry it very well in order to ensure it is stored for a longer period. The significant difference observed in crude protein, crude fibre, ether extract and nitrogen free extract of DAR in this study implies that locations has effect on the nutrient composition of DAR. Therefore, if it is to be chosen as feed ingredient, there is a need to run the chemical analysis to ascertain the nutrient content.

Despite the varied levels of these proximate components, the range of crude protein (24.78-27.69%) was higher compared with most oil seed by-products such as peanut hulls (7.00%), soybean hulls (13.10%), rapeseed hulls (16.10%) and palm kernel meal (16.70%) as reported by Heuzé *et al*. (2016) and Oyeyinka and Oyeyinka (2019). The crude protein was however similar with the value of 25% reported by NIAS (2021) for cotton seed cake. The higher crude protein of DAR in comparison to these oil seed by-products signifies its high nutrient value. The crude fibre range (6.56-8.47%) was lower than in the most oil seed by-products including cotton seed cake (NIAS, 2021). This further confirms its high quality. Therefore, the lower crude fibre content will warrant inclusion in feed especially when dealing with monogastric feed production.

The range of ether extract (5.80-7.57%) was lower compare to palm kernel meal (9.20%) and rapeseed hulls (13.20%) as reported by Heuzé *et al*. (2017) and Heuzé *et al.* (2019) respectively. It is however higher than several other oil seed by-products such as peanut hulls (2.00%). Therefore, incorporating DAR in feed will argument the fat deficiencies in certain alternative oil seed by-

products. The fat would also argument energy requirement and reducing feed dustiness. Besides complementing the fat deficiency in some oil seed by-products, it would help in augmenting the low fat in blood meal and fish meal, if they form sole protein sources. This further posited that DAR is quite a high quality feed ingredient.
The range of ash (17.27-18.86%) was higher than 4.70% observed in palm kernel meal (Heuzé *et al*. 2016) and 5.50% in rapeseed hulls (Heuzé *et al*. 2017). The range of nitrogen free extract (28.11-33.67%) was low, which therefore places it as protein raw material rather than energy source.
The mineral composition of DAR obtained from various locations is shown in Table 2. Only sodium and potassium were significantly different (p<0.05). DAR obtained from 3 locations (Biliri, Numan and Sade) had highest sodium content (4.22, 4.31 and 4.16 mg/100g respectively) while DAR obtained from 4 locations (Das, Telde, Ibi and Damaturu) had lowest (3.54, 3.44, 3.50 and 3.53 mg/100g respectively). DAR obtained from Jajimaji had highest (7.14 mg/100g) potassium while DAR obtained from Boi had lowest (6.07 mg/100g). The range of calcium (2.92-3.77mg/100g) observed in this study was higher than in cotton seed cake, groundnut cake, soybean cake but lower than in peanut hulls, sunflower cake and roselle seed cake (NIAS, 2021). The range of phosphorus (4.06-4.68mg/100g) was higher when compared with peanut hulls (Heuzé *et al*., 2017) and soybean hulls (Heuzé *et al*., 2017). The appreciable contents of calcium and phosphorus would help to alleviate calcium and phosphorus deficiencies precipitated by most ingredients.
Table 3 shows the fibre fractions of DAR obtained from different locations. NDF, ADF and cellulose were significantly different (p<0.05) among the parameters determined. DAR obtained from Numan, Sade and Jajimaji had highest % NDF (59.67, 59.00 and 60.73 % respectively) while DAR obtained from Gombe had the lowest value (49.73%).

Table 1: Proximate composition (%) of Soybeans by-product (dried *awara* residue) obtained from different locations

Locations	Dry matter	Crude protein	Ash	Ether extract	Crude fibre	NFE
Das	89.11	24.95^{cd}	18.86	6.22^{bc}	6.56^{c}	32.51^{ab}
Boi	89.83	25.85^{bcd}	17.91	6.25^{bc}	7.52^{abc}	32.30^{ab}
Telde	89.68	24.78^{d}	18.18	5.80^{c}	7.24^{bc}	33.67^{a}
Gombe	90.03	26.11^{bc}	18.56	6.39^{bc}	8.47^{a}	30.51^{bcde}
Biliri	88.95	25.93^{bcd}	18.36	6.65^{abc}	8.39^{a}	29.63^{cde}
Ibi	89.23	25.06^{cd}	17.27	6.54^{abc}	8.09^{ab}	32.27^{ab}
Numan	88.30	25.32^{cd}	17.36	6.35^{bc}	7.35^{abc}	31.92^{abc}
Sade	89.32	25.34^{cd}	18.72	7.23^{ab}	7.21^{bc}	30.82^{bcd}
Jajimaji	89.52	27.69^{a}	18.54	7.23^{ab}	7.95^{ab}	28.11^{e}
Damaturu	89.11	26.63^{b}	18.29	7.57^{a}	6.56^{c}	32.51^{ab}
Mean	89.31	25.77	18.21	6.62	7.53	31.43
SEM	0.85	0.61	0.65	0.53	0.52	1.20
P-value	0.0599	<.0001	0.1391	0.0181	0.0052	<.0001

SEM= pooled standard error of mean. ^{abc} Different superscripts in the same row are significantly different ($P < 0.05$). NFE=nitrogen free extract.

DAR obtained from Sade had highest % ADF (45.40%) with the lowest value obtained in Telde (35.82%). Sade also had highest cellulose (42.43%) while Telde had the lowest (33.90%).

The range of neural detergent fibre (49.73-60.73%) was comparable to 55.80% DM rapeseed hulls, and lower than 64.40% DM soybean hulls, 66.40% DM peanut hulls and 73.00% DM palm kernel meal (Heuzé *et al*., 2016; Adeyeye and Afolabi., 2018). That of acid detergent fibre (35.82-45.40%) was lower compared to 42.20% DM rapeseed hulls, 44.80% DM palm kernel meal, 46.20% DM soybean hulls and 56.40% DM peanut hulls (Heuzé *et al*., 2017; Ogunlade and Adeyemi, 2017). That of lignin (1.91-2.96) was slightly similar to 2.30% DM soybean hulls, and lower than 13.40% DM palm kernel meal, 22.40% DM peanut hulls and 22.70% DM rapeseed hulls (Heuzé *et al*., 2019; Oyeyinka and Oyeyinka, 2019). The lower ADL indicates that inclusion of *awara* waste in diets would not interfere with nutrient digestibility particularly by non-ruminants.

Table 2: Mineral composition (mg/100g) of Soybeans by-product (*awara* residue) obtained from different locations

Locations	Ca	P	Na	K	Mg	Zn	Fe	Co
Das	2.92	4.11	3.54^{c}	6.43^{bc}	4.32	64.66	42.47	6.05
Boi	3.77	4.37	3.93^{abc}	6.07^{c}	3.87	67.06	41.50	5.96
Telde	3.05	4.43	3.44^{c}	7.28^{ab}	4.13	68.01	41.63	5.77
Gombe	3.12	4.68	4.12^{ab}	7.05^{abc}	3.74	68.04	40.23	5.85
Biliri	2.92	4.28	4.22^{a}	7.28^{ab}	3.73	68.37	41.46	6.23
Ibi	3.14	4.06	3.50^{c}	7.09^{ab}	3.69	66.67	40.47	5.62
Numan	3.12	3.96	4.31^{a}	6.97^{abc}	4.25	68.75	41.58	6.69
Sade	3.21	4.45	4.16^{a}	6.27^{bc}	3.88	66.48	43.38	5.61
Jajimaji	3.54	4.10	3.66^{bc}	7.52^{a}	4.45	67.20	43.12	6.49
Damaturu	2.92	4.17	3.53^{c}	7.14^{ab}	4.62	64.12	40.47	6.34
Mean	3.17	4.26	3.84	6.91	4.07	66.94	41.63	6.06
SEM	0.34	0.35	0.21	0.47	0.43	1.71	1.32	0.33
P-value	0.1366	0.5155	<.0001	0.0238	0.2539	0.0791	0.1942	0.0527

SEM= pooled standard error of mean. [abc] Different superscripts in the same row are significantly different ($P < 0.05$).

Table 4 shows the essential amino acid compositions of DAR obtained from different locations. Arginine, lysine, methionine, phenylalanine and threonine were significantly different (p<0.05) among the essential amino acid determined. DAR obtained from Numan had highest arginine and methionine (4.67 and 2.45 g/16gN, respectively), while DAR obtained from Jajimaji had lowest arginine (3.59 g/16gN) and DAR obtained from Boi had lowest methionine (1.10 g/16gN). Also, DAR obtained from Das, Boi and Biliri (7.26, 7.23 and 7.35 g/16gN respectively) had highest lysine while those obtained from Sade and Damaturu had the lowest lysine (5.41 and 5.29 g/16gN). DAR obtained from Telde had highest phenylalanine (2.45 g/16gN) while those obtained from Jajimaji had lowest (1.09 g/16gN). For threonine, DAR obtained from Boi (3.08), Damaturu (2.82) and jajimaji (2.69) were the highest (p<0.05) while those obtained from Das, Telde and Gombe had the lowest (1.48, 1.99 and 1.85 g/16gN, respectively).

Table 3: Fibre fractions (%) of Soybeans by-product (*awara* residue) obtained from different locations

Locations	NDF	ADF	ADL	Hemicellulose	Cellulose
Das	58.01^{ab}	40.09^{bcd}	2.31	17.92	37.78^{bcd}
Boi	55.54^{abc}	39.44^{bcd}	2.27	16.11	37.16^{cd}
Telde	52.73^{bc}	35.82^{d}	1.91	16.91	33.90^{d}
Gombe	49.73^{c}	42.69^{abc}	2.58	17.04	40.11^{abc}
Biliri	57.98^{ab}	39.78^{bcd}	2.64	18.20	37.13^{cd}
Ibi	55.72^{abc}	40.45^{bcd}	2.25	15.27	38.20^{abcd}
Numan	59.67^{a}	40.30^{bcd}	2.43	19.37	37.87^{bcd}
Sade	59.00^{a}	45.40^{a}	2.96	13.60	42.43^{a}
Jajimaji	60.73^{a}	44.11^{ab}	2.04	16.62	42.08^{ab}
Damaturu	52.74^{bc}	38.45^{cd}	2.20	14.29	36.26^{cd}
Mean	56.19	40.65	2.36	16.53	38.29
SEM	2.81	1.80	0.35	2.43	2.01
P-value	0.0016	0.0009	0.1366	0.1226	0.0015

SEM= pooled standard error of mean. ^{abc} Different superscripts in the same row are significantly different ($P < 0.05$). NDF= neutral detergent fibre, ADF= acid detergent fibre, ADL= acid detergent lignin

Table 5 shows the non-essential amino acid composition of DAR obtained from different locations. Only alanine was significantly different (p<0.05) among the parameters determined. The DAR obtained from Telde and Jajimaji had the highest alanine content (3.45 and 3.40 g/16gN) while those obtained from Numan had the lowest (2.48 g/16gN).

The two limited amino acids in most plant origins are lysine and methionine (Sá *et al*., 2021). The range of lysine (5.29-7.35 g/16gN) observed in this study was higher than 4.00 g/16gN in cotton seed cake and 4.6 g/16gN in peanut hulls,

Table 4: Essential amino acid compositions (g/16gN) of Soybean by-product (*awara* residue) obtained from different locations

Locations	Arg	His	Iso	Leu	Lys	Met	Phe	Thr	Val
Das	4.10^{ab}	2.47	3.38	7.37	7.26^{a}	1.35^{cd}	1.93^{ab}	1.48^{d}	4.56
Boi	3.40^{bc}	2.06	3.13	7.60	7.23^{a}	1.10^{d}	1.77^{bc}	3.08^{a}	4.56
Telde	4.38^{ab}	2.48	2.83	7.68	6.10^{bc}	1.56^{bcd}	2.45^{a}	1.99^{d}	4.61
Gombe	3.91^{ab}	3.17	2.99	7.31	6.64^{ab}	2.33^{ab}	2.01^{ab}	1.85^{d}	4.84
Biliri	4.28^{ab}	2.38	3.28	6.86	7.35^{a}	1.52^{cd}	1.22^{cd}	2.21^{bcd}	4.97
Ibi	3.87^{ab}	2.17	2.82	7.68	5.54^{bc}	2.63^{a}	1.78^{bc}	2.41^{bcd}	3.96
Numan	4.67^{a}	2.56	3.35	7.72	6.81^{ab}	2.45^{a}	2.01^{ab}	2.30^{bcd}	3.88
Sade	4.21^{ab}	2.62	3.08	7.29	5.41^{c}	1.97^{abc}	1.76^{bc}	2.04^{cd}	4.49
Jajimaji	2.88^{c}	2.73	3.36	7.35	5.76^{bc}	1.82^{abcd}	1.09^{d}	2.69^{abc}	3.74
Damaturu	3.59^{bc}	3.24	2.95	6.98	5.29^{c}	1.33^{cd}	1.90^{ab}	2.82^{ab}	4.17
Mean	3.93	2.59	3.12	7.38	6.34	1.81	1.79	2.29	4.38
SEM	0.43	0.43	0.20	0.35	0.50	0.33	0.14	0.22	0.46
P-value	0.0045	0.1044	0.5862	0.0154	<.0001	0.0003	0.0002	<.0001	0.0774

*Tryptophan: Not determined. *SEM*= pooled standard error of mean. ^{abc} Different superscripts in the same row are significantly different ($P < 0.05$). Arg=arginine, His=Histidine, Leu=leucine, Lys=lysine, Met=methionine, Phe=phenylalanine, Thr=threonine, Val=valine however, it was lower than 6.2% protein in rapeseed and 6.3% protein in soybean hulls (Heuzé *et al*., 2017; Ogunlade and Adeyemi, 2017). The range of methionine (1.10- 2.63 g/16gN) was higher than 1.1 g/16gN in soybean hulls, 1.40 g/16gN in cotton seed cake and 1.7 g/16gN in Palm kernel meal (Heuzé *et al*., 2016; Heuzé *et al*., 2019; Oyeyinka and Oyeyinka, 2019). The appreciable values of lysine and methionine and probably the other amino acids would help in complementing lysine and methionine deficiencies specifically when dealing with cereals.

The varying nutrient levels observed in different locations are consistent with previous reports (Babatunde *et al*., 2021) and may be due to differences in processing methods. Makinde *et al*. (2019) and Ajibade *et al.* (2021) also observed that the varying nutrient levels in most plant by-products may be attributed to different processing methods. O'Toole (2016) and Vinayashree and Vasu (2021) described the protein content in most soybean by-products as of high quality.

Conclusion

The study showed that dried awara residues vary in nutrient content among households, with high protein and low fiber levels observed. It is recommended to further explore the potential of this material for animal feed.

Conflict of interest

We declared no potential conflict of interest that would emanate from this paper.

Table 5: Non-essential amino acid compositions (g/16g N) of Soybean by-product (*awara* residue) obtained from different locations

Locations	Alanine	Aspartic	Glutamic	Serine	Cystine	Glycine	Proline	Tyrosine
Das	2.89[abc]	2.50	6.01	2.39	1.08	3.20	1.17	2.30
Boi	3.38[ab]	2.44	3.91	2.57	0.96	2.99	1.15	2.19
Telde	3.45[a]	2.59	3.73	2.23	0.87	3.03	1.16	1.95
Gombe	2.77[bc]	2.82	3.97	2.34	1.21	3.09	1.13	2.17
Biliri	3.08[abc]	2.58	4.01	2.46	1.16	3.20	1.60	2.48
Ibi	3.31[ab]	2.44	4.18	2.41	1.06	3.22	1.18	2.54
Numan	2.48[c]	2.62	4.11	2.52	0.93	3.70	1.45	1.88
Sade	2.86[abc]	2.66	4.37	2.67	0.71	3.47	1.13	2.36
Jajimaji	3.40[a]	2.87	4.06	2.39	1.04	2.73	1.10	1.98
Damaturu	2.99[abc]	2.78	4.54	2.77	0.80	3.01	1.16	1.80
Mean	3.06	2.63	4.29	2.48	0.98	3.16	1.22	2.17
SEM	0.28	0.22	1.04	0.26	0.19	0.35	0.26	0.30
P-value	0.0058	0.5499	0.6106	0.5796	0.1898	0.2391	0.6646	0.1574

SEM= pooled standard error of mean. [abc] Different superscripts in the same row are significantly different (P<0.05).

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