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Evaluation of Different Processing Techniques on the Nutritional Values of Soya Bean By-Products for Fish Feed

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Abstract
The study was conducted to assess the nutritional composition of soya bean and some of its byproducts on different processing techniques. The result for whole soya bean on different processing techniques shows that the crude protein composition was significantly higher ($p<0.05$) in boiled whole soya sample (52.48 ± 0.12^a) followed by soaked (44.98 ± 0.49^b), toasted (40.40 ± 0.35^c) and raw (28.42 ± 0.61^d) soy bean sample but the boiled sample has least energy ash and moisture when compared to other processing techniques. The raw whole soya bean sample is significantly ($p<0.05$) higher in energy (30.47 ± 0.55^a) compared to other processing methods. However, the result also revealed that the crude protein composition of raw soy bean offal (24.48 ± 0.42^a) was significantly ($p<0.05$) higher compared to other processing methods followed by soaked (14.03 ± 0.23^b), boiled (8.76 ± 0.00^c) and toasted (8.72 ± 0.00^c) soya bean offal respectively but toasted soy bean sample which has lowpercentage crude protein was significantly ($p<0.05$) higher in energy compared to other processing method with an average of (75.91 ± 0.21^a). Furthermore, crude protein composition of tofu residues was significantly ($p<0.05$) higher in raw residue (27.88 ± 0.00^a) followed by boiled residue (22.83 ± 0.03^b) and toasted residue (20.33 ± 0.00^c) but boiled residue was significantly ($p<0.05$) higher in energy (51.83 ± 0.45^a) compared to other processing methods. Based on the result in the present study,it can be concluded that boiling is the most effective processing methods of whole soya bean meal in fish feed production.

1. Introduction

Good nutrition in animal production system is essentials to economically produce a healthy high quality product [1]. In fish farming, nutrition is critical because feed represent 60-80% of the production cost [1]. Fish nutrition has advanced dramatically in recent years with the development of new, balanced diets that promotes optimal fish growth and health [1]. The development of new species specific diets formulation supports the fish farming industry as it expand to satisfy increasing demand for affordable, safe, and high quality fish and seafood product [1].

Fisheries have substantial socioeconomic, nutritional and food security importance to both human and animal race. [18], reported that, the contribution of the fisheries to the

Nigeria's socioeconomic wealth are enormous when considered against the background of employment creation, income generation, provision of valuable animal protein with easy digestibility and cholesterol free, rural development and foreign exchange inflow. In order to enhance agricultural production, improve food security, and reduce the poverty level in developing countries, a search for cheap and locally available feedstuffs is required [18].

Nigerian feed stuffs have been in the decline in recent years because of the diminishing output of certain traditional crops [18]. Recent statistics demonstrated that Nigeria relies on import to meet the need of an expanding livestock and aquaculture industry [18]. This has result in increase in price of food and feed resources in the country which aggravated high cost of fish feed which has been a major problem of fish farmers in Nigeria [18].

Many by-products food ingredient that are not consumed by human can be obtain very cheap to be purchase as waste product from agriculture either farm residues or processing industries residues and are to serve as waste management in enhancing good sanitation [25]. In recent time due to high cost of some ingredient like fish meal, byproducts or some Nonconventional feed resources (NCFR) are incorporated into feed to substitute for some of the requirement in the feed. Examples are Tofu residues, soya beans offal, blood meal bone meal yam peel and other Agricultural byproducts to substitute energy and protein sources in the feed [35]. The aim of this research is to determine the nutritional evaluation of soya beans and its two selected by-product (Tofu residue and soybean offal) using different processing techniques.

2. Materials and Methods

2.1. Experimental Location

The experiment was carried out at fish feed meal and Animal Science Lab, and Agric Chemical laboratory of the Faculty of Agriculture, UsmanuDanfodiyo University Sokoto. Sokoto is located in the extreme North-West of Nigeria, near the confluence of the Sokoto River and River Rima. The state is within longitudes 11°30-130°50 E and latitude 4°-6° 40° N (Wikipedia, 2012). Sokoto is located at the dry sahel surrounded by sandy savannah and isolated hills with an annual average temperature of 28.3°C (82.9°F). Rainfall starts late May and ends early September with mean annual rainfall ranging from 300-1300mm.

The two seasons are dry season and wet season. Dry season begin from October to April and extend to May/June in some part. Wet season commences in May and last up to September to October. Harmattanis experienced between November and February while heat is more severe around March and April [25].

2.2. Sample Collection

The sample of Soya beans (*Glycin max*) were sourced from Katsina State, Sabuwa Local Government, Unguwar Bako, HayinSada.

2.3. Processing Methods of Feedstuffs Ingredients

2.3.1. Whole Soya Bean

4kg of whole soya was collected and divided into four portions. First portion was dried, grinded, lath as raw sample and latter subjected to analysis. Second portion was soaked in hot water which was washed, changed with cold water 2 times each after 8hrs up to 24hrs, dried, grinded, leaved as soaked sample and lettered subjected to analysis [51]. The third portion was cooked to the boiling point, removed, dried, grinded, leave as boiled sample and lettered subjected to analysis [33]. The last portion was toasted, dried, grinded, leaved as toasted sample and lettered subjected to analysis [33].

2.3.2. Soya Bean Offal

4kg of the whole Soya bean was crushed with grinding stone locally, the whole soya broke and latter winnowed to separate the soya and offal. The offal was divided into four different portions. First portion was dried, grinded, leaved as raw sample and lettered subjected to analysis. The second portion was soaked in water up to 8hrs, removed, dried, grinded, leaved as soaked sample and lettered subjected to analysis. The third portion was cooked/boiled, removed, dried, grinded, leaved as boiled sample and lettered subjected to analysis [33]. The last portion was toasted, dried, grinded, leaved as toasted sample and lettered subjected to analysis.

2.3.3. Tofu Residue

4kg of Soya bean was soaked in water for 3hrs locally, grinded with grinding machine, mixed with water again, and finally sieved the mixture to separate the Tofu and Tofu Residue and lettered dried the residue. The residue obtained was divided into three different portions. The first portion was grinded, leaved as raw sampled and subjected to analysis. The second portion was cooked/boiled, dried, grinded again, leave as boiled sample and lettered subjected to analysis. The last sample was toasted, dried, grinded, leaved as toasted sample and lettered subjected to analysis.

2.4. Proximate Composition Analysis of the Feedstuff Ingredients

The proximate composition of the feed stuffs were analyzed after processing following the procedures of [4].

2.4.1. Determination of Moisture Content

Two grams of each samples was dry in an oven at 105°C for 24hrs. The samples were then cooled in desiccators. Further analysis was done using the same procedures until a constant weight was observed in the sample and moisture content was determine through the following formula.

$$\% \text{ Moisture} = \frac{W2-W1}{W1-W0} \times 100$$

Where: W_0 = weight of empty crucible

W_1 = Initial weight of sample
W_2= Final weight of sample

2.4.2. Determination of Ash

2g of each samples was ash in the thermal furnace at 600°C for 3hours, after which were cooled in the desiccators. The ash content was been determine through the formula.

$$\% \text{ Ash} = \frac{W2-Wo}{W1-W0} \times 100$$

Where: W_0= weight of empty crucible
W_1= Initial weight of sample before ashing
W_2= Final weight after ashing

2.4.3. Lipid Determination (Ether Extract)

The Soxhlet method AOAC was adopted for this determination. 2g of samples was weight into a thimble to which its mount was plugged with cotton. The sample in thimble was directly extracted with petroleum ether. The residue in the after solvent removal represent as the fat content of the sample. The percentage crude lipid was calculated using the following formula:

$$\% \text{ Crude lipid} = \frac{W2-W1}{2g} \times 100$$

Where: W_1 = weight of the empty thimble
W_2 = weight of the thimble with the lipid

2.4.4. Crude Fiber Determination

This is done using [4] methods. The principle of the method is based on loss of crude fiber when ignited after being digested with acid and base. 2g of each sample was defatted as described in lipid determination. The defatted sample was then transferred into 600cm^3 beaker into which 200ml of 1.25% H_2SO_4 was added. The content was boiled for 30mins on hot plate. After boiling, the mixture was cooled and filtered through poplin cloth. The residue was then washed with hot distilled water and drained. The drained residue was then quantitatively returned to the original beaker and 200ml of 1.25 NaOH were added. The content was then boiled for 30mins, filtered as above and washed with hot distilled water. Finally, the residue in the poplin cloth was then put in crucible for drying in the oven and the contents quantitatively put in pre-weighed crucible and reweighed. The crucible was then ignited at 600°C for two hours, cooled and reweighed. The crude fiber content was the calculated by the formula below:

$$\% \text{ Fiber} = \frac{W1-W2}{2g} \times 100$$

Where: W_1 = Dry weight
W_2 = Ash weight

2.4.5. Crude Protein Determination

The crude protein of each sample was determined by using the macro kjeldhal method [4]. The principles of the method is based on the conversion of protein nitrogen and that of other compounds than nitrate into ammonium sulphate by acid digestion with strong acid usually H_2SO_4 to give ammonium sulphate $(NH_4)_2SO_4$, the ammonium is then digested using sodium hydroxide. The solutions are then distill and collect into boric or sulphuric acid solution in form of ammonium ion. The nitrogen content is then estimated by titration of the borate formed with standard acid ($H_2SO_4$and HCL) using Methyl orange indicator.

The protein present is then calculated by multiplying the nitrogen concentration by conversion factor, usually 6.25 (equivalent to 16g N/100 protein). 0.5g of sample was weighed into kjeldhal digestion flask. 0.5g of kjeldhal digestion table (Copper Catalysts) and 10cm^3 of Concentration H_2SO_4 acid were added. The content was then heated in kjaldhal digestion until it digest clear (approximately 2hrs). After the digestion had been completed, the flask was cooled, diluted with 10cm^{3}distilled water and filtered into 100cm^{3}volumetric flask and made up of the mark with distilled water. 10cm^3 of homologous aliquot solution was pipette into distillation flask and 20cm^3 of 45% NaOH solution was added. The content was diluted to about 200cm^3 with distilled water and distilled into on receiving flask containing 20cm^3 boric acid indicator solution.

The ammonium in sample liberated into boric acid color of the solution changed from pink to green. The sample collected with ammonia was then titrated against 0.01m HCL to end point, which gave the amount of ammonia content in the sample. The colour changed from green to pink at the point and then titer value recorded was recorded.

$$\% \text{ Nitrogen} = \frac{TV \times 0.01 MOFHCL \times 14.5}{Sampleweight \times molesof Aliquot} \times 100$$

TV= Titre Value
NA = Normality of Acids= 0.01m HCL
Atomic mass of Nitrogen = 14

The concentration of H^+ (mole) required to reach the end point is equivalent to the concentration of nitrogen in the sample. The protein present was calculated by multiplying the nitrogen concentration by conversion factors of 6.25 9equivalent 16Gn/100g protein) as in the following equation:

$$\text{Crude Protein (\%)} = \%N \times 6.25$$

2.4.6. Determination of Nitrogen Free Extract (Carbohydrate)

The Nitrogen Free Extract (N.F.E) referred to as carbohydrate is not determined directly, but obtained as difference between the total dry the sum ash, protein, crude fat, and fiber subtracted from 100

$$NFE = 100 - (\% \text{ Ash} + \% \text{ Crude Fiber} + \% \text{ Crude lipid} + \% \text{ Crude protein})$$

2.5. Statistical Analysis

Complete Randomized Design (CRD) was adopted for the experiment. The data obtained were subjected to analysis of Variance (ANOVA) and means were separated using Duncan's Multiple Range Test (DMRT) [11] using Statistical package for Social Science (SPSS) Version 20.0 for window.

3. Result

The result of the proximate of composition of whole soya bean meal on different processing methods such as raw (control), boiling, toasting and soaking was presented in table 1. The result showed that there was no significant (p > 0.05) difference in moisture content of raw (6.82±0.13[a]), soaked (6.87±0.07[a]) and toasted (7.08±0.14[a]) soya bean meal samples but significantly (p<0.05) differed with boiled soy bean meal sample (3.27±0.88[b]). The ash composition result from table 1 showed that raw soya bean meal sample (4.77±0.15[a]) differed significantly (p<0.05) from toasted (2.92±0.11[b]), soaked (3.03±0.88[b]) and boiled (3.04±0.64[b]) soya bean meal samples but there was no significant (p>0.05) between toasted, soaked and boiled soya bean meal samples. The result of fiber composition also revealed the significant (p<0.05) difference between the whole processed soya bean meal samples starting from raw (8.06±0.09[a]), toasted (6.21±0.37[b]), boiled (5.37±0.14[c]) and soaked (4.58±0.24[d]). The highest lipid composition was revealed in raw soya (29.19±0.59[a]) and boiled (29.33±0.82[a]) soya beans with no significant (p>0.05) difference from soaked (27.33±0.82[a]) soy bean meal. The lowest value was revealed in toasted soya (24.30±0.18[b]) with significant (p<0.05) different as presented (table 1).

The highest value of crude protein was recorded in boiled (52.48±0.12[a]) with significant (p<0.05) different from other processing methods that is soaked (44.98±0.61[b]), toasted (40.40±0.37[c]) and raw (28.42±0.61[d]) soya bean meal (table 1). Finally, the result of Nitrogen Free Extract (NFE) composition value was higher in raw sample (30.47±0.55[a]), toasted sample (25.27±0.37[b]), soaked sample (17.33±0.65[c]) and boiled sample (12.04±0.74[d]) with significant (p<0.05) difference from each processing methods (table 1).

Table 1. *Proximate composition of whole soya bean on different processing method.*

Processing methods	Moisture %	Ash %	Crude fiber%	Crude lipid%	Crude protein%	NFE%
Raw soya bean	6.87±0.13[a]	4.77±0.15[a]	8.06±0.09[a]	29.19±0.59[a]	28.42±0.61[d]	30.47±0.55[a]
Soaked soya bean	6.87±0.07[a]	3.03±0.88[b]	4.58±0.24[d]	27.33±0.82[a]	44.98±0.49[b]	17.33±0.65[c]
Boiled soya bean	3.27±0.60[b]	3.04±0.64[b]	5.37±0.14[c]	29.33±0.82[a]	52.48±0.12[a]	12.04±0.74[d]
Toasted soya bean	7.08±0.14[a]	2.92±0.11[b]	6.21±0.74[b]	24.33±0.18[b]	40.40±0.37[c]	25.27±0.37[b]

Values in column denoted by same letters are not significant different (p>0.05)

For the soya bean offal/bran, the result of the proximate composition was subjected to different processing methods such as raw (controlled), boiling, soaking and toasting are presented in table 2. The result showed that, the highest moisture content was recorded in raw sample (7.48±0.13[a]) followed by soaked sample (7.20±0.08[a]) and boiled sample (7.18±0.10[a]) but differed significantly (p<0.05) in moisture content of toasted sample (5.22±0.133[b]). Boiled and toasted recorded the highest ash content (9.04±0.26[a]) and (9.23±0.13[a]) respectively with no significant (p>0.05) difference. The lowest value was recorded in soaked (6.97±0.08[b]) and raw (5.95±0.10[c]) offal which differed significantly (table 2). The highest values of crude fiber was recorded in raw sample (19.99±0.14[a]) followed soaked sample (19.80±0.14[a]) and boiled sample (19.39±0.31[a]) with no significant (p>0.05) difference. The lowest value was recorded in toasted sample (13.99±0.17[b]) with significant (p<0.05) different (table 2). The result also revealed that the higher value of lipid was recorded in soaked (8.97±0.28[a]) followed by boiled sample (1.89±0.20[b]) with significant (p<0.05) difference. The lowest lipid content value was recorded in toasted (0.92±0.14[c]) and raw (0.72±0.12[c]) with no significant (p>0.05) difference. In addition, the higher value of crude protein was recorded raw offal (24.48±0.41[a]) followed by soaked sample (14.03±0.23[b]) with significant (p<0.05) difference while the lowest value was recorded in toasted (8.76±0.00[c]) and boiled offal (8.72±0.00[c]) with no significant difference (table 2). Toasted soya beans offal was recorded the highest NFE (75.91±0.21[a]) followed by boiled offal (73.12±0.34[b]) with significant (p<0.05) difference. The lowest values of NFE was reported in soaked (63.15±0.54[c]) and Raw (61.37±0.18[c]) offal with a significant (p<0.05) difference (table 2).

Table 2. *Proximate composition of soya bean offal on different processing method.*

Processing methods	Moisture%	Ash%	Crude fiber%	Crude lipid%	Crude protein%	NFE%
Raw offal	7.48±0.13[a]	5.95±0.10[c]	19.99±0.14[a]	0.72±0.12[c]	24.48±0.41[a]	61.37±0.18[d]
Soaked offal	7.20±0.08[a]	6.97±0.08[b]	19.80±0.14[a]	8.97±0.28[a]	14.03±0.23[b]	63.15±0.54[c]
Boiled offal	7.18±0.10[a]	9.04±0.26[a]	19.39±0.31[a]	1.89±020[b]	8.76±0.00[c]	73.12±0.34[b]
Toasted offal	5.22±0.13[b]	9.23±0.13[a]	13.99±0.17[b]	0.92±0.14[c]	8.72±0.00[c]	75.91±0.21[a]

Values in column denoted by same latter are not significant different (p>0.05)

While the result of proximate composition of Tofu residue subjected to different processing method such as raw (controlled), boiling and toasting are presented in table 3. The result shows that the higher moisture content was recorded in raw residue sample (4.96±0.02[a]) and boiled residue sample (4.44±0.15[b]) while the lowest value was recorded in toasted residue sample (4.10±0.03[c]) with a significant (p<0.05) between processing methods.

Similarly, ash content of the raw residue recorded the higher value (9.04±0.09[a]) which differed significantly with other processing methods. The lowest value was recorded in toasted (4.48±0.43[b]) and boiled (5.04±0.08[b]) with no significant (p>0.05) different. The result also revealed that, the crude fiber composition show no significant (p>0.05) difference between boiled residue sample (9.15±0.15[b]) and toasted residue sample (9.42±0.21[b]) but significantly ($p<0.05$) differed from raw residue sample (10.24±0.19[a]).

The toasted residue sample recorded the highest crude lipid (22.378±0.99[a]) followed by raw (21.57±0.53[a]) with no significant difference, the lowest value was recorded in boiled residue (15.80±0.06[b]) with a significant difference. The crude protein content was higher recorded in raw residue sample (27.88±0.00[a]) followed by boiled residue sample (22.83±0.03[b]) and soaked residue sample (20.83±0.00[c]) with significant ($p<0.05$) difference (table 3).

Boiled residue recorded the highest value of NFE (51.83±0.48[a]) with significant difference with other processing methods, the lowest values was reported in raw (36.75±0.45[c]) and toasted residue (47.87±0.04[a]) which differed significantly.

Table 3. *Proximate composition of Tofu residue on different processing methods.*

Processing method	Moisture%	Ash%	Crude fiber%	Crude lipid%	Crude protein%	NFE
Raw residue	4.96±0.02[a]	9.04±0.09[a]	10.24±0.19[a]	21.57±0.53[a]	27.88±0.00[a]	36.75±0.45[c]
Boiled residue	4.44±0.15[b]	5.04±0.08[b]	9.15±0.15[b]	15.80±0.06[b]	22.83±0.03[b]	51.83±0.45[a]
Toasted residue	4.10±0.03[c]	4.48±0.43[b]	9.42±0.21[b]	22.38±0.99[a]	20.83±0.00[c]	47.87±0.04[b]

Values in column donated by the same latter are not significant difference ($p>0.05$)

4. Discussion

The chemical composition of whole soy sample was presented in Table 1. The moisture composition of the whole soya (soaked, raw and toasted) values recorded is similar to those reported in [13], [5] and [47] whose reported values range from (5 – 8%) but lower in moisture content than those reported in [28] which is (11.50%), the moderate and lower moisture content reported in the present studies is probably due to processing method. The ash composition of raw, soaked, toasted and boiled whole soya sample in Table 1 are almost similar to [13], [49] and [47]reported as 4.5%, 4.86% and 5.50% but lower that ash content of [28] and [5] reported as 6.40% and 6.75% respectively. This could be due to drying process.

The fiber value composition of raw, boiled, soaked and toasted soya bean samples in the present study was lower compares to [28] and [13] who's reported as 11.60% and 9.00% respectively. Similarly, the fiber content boiled soya sample was similar to those reported in [49]. The fiber content of toasted soya bean meal sample reported is almost similar compares to [5] who reported 6.67%. The fiber content of raw soya bean sample (8.06) in the present study was higher compares to [47], [49] and [5] whose reported as 7.13%, 5.12% and 6.67% respectively. This might be due the processing methods employed. The lipid content of raw soaked and boiled soya bean meal samples in table 1 was higher from [28], [49], [47], [5] and [13] reported as 24.70%, 18.38%, 15.52% 21.18% and 15.5% respectively but toasted soy bean sample is similar to lipid content of [28].

The crude protein values of boiled soya bean meal (52.48%CP) reported was higher to those reported in [13](33.00% CP), [49] (37.08% CP), [47] (41.60% CP) and [28] (43.6%CP). The highest value reported was probably due to processing methods variation, environmental condition where experiment carried out, and climatic condition of soil where soya beans are cultivated. Furthermore the crude protein of soaked and toasted soya samples (40.4 and 44.98% CP) are almost close to the same as what was reported above.

The value of Nitrogen Free Extract (NFE) composition reported for raw soaked boiled and toasted soy bean samples in the present study was lower compares [5], [47], [28] and [13] whose reported as 31.82%, 38.10% 31.85% and 31.70 respectively but raw soya samples (30.47) nitrogen free extract was higher compares to [49]. All the difference may be attributed arise due the processing method and environmental situation where experiment carried out.

In the case of soya bean offal/bran, the moisture composition of raw, soaked and boiled in the present study was similar to those reported in [5] and [13] as (8% and 7% respectively). The moisture content of toasted offal sample (5.22%) was lower compare to those in [5] and [13] (8% and 7% respectively). Probably due to processing methods. Similarly, the ash composition raw, soaked boiled and toasted soya bean offal sample in the present study was higher than those reported in [5] and [13] reported as (4.0% and 5.0%). The fiber composition of raw, soaked and boiled soya bean offal in the present study was higher compares to those reported in [5] and [13] whose reported 15% and 17% respectively but toasted soy bean offal fiber (13.99%) is low compares to those reported in [5] and [13]. The value of the lipid composition of boiled soy bean offal in the present study was higher to those reported in [13] and [5] who's reported as 2.10% and 0.95% respectively. While the lipid composition of toasted and raw soya bean offal is closely similar to those reported [13] reported as (0.95%) and those of boiled sample is also closely similar to this in [5] reported as (2.1%). The variation was probably due to processing method and experimental condition.

The crude protein percent of raw and soaked in the present study was higher to those reported in [5] and [13] whose reported as 12.00% and 10.00% respectively. However, boiled, and toasted soya bean offal samples crude protein in the present study was lower compare to those reported in [5]. The variation in the values was probably due to processing methods and some other factors. The Nitrogen Free Extract (NFE) composition of raw, soaked, boiled and toasted soya bean offal samples was lower compares to [13] and [5] who's reported as 77% and 76% respectively. This might be due some environmental condition where experiment carried out and processing method of ingredients.

While for the Tofu residues, the moisture composition of raw, boiled and toasted residue in the present study are almost similar compares to those in [7] and [16] as (5.13% and 4.21% respectively) but lower than those in [9] reported as 6.67), this may due to the processing methods. The ash composition of raw and boiled residue in the present study was higher compare to [9], [7] and [16] (3.14%. 4.49% and 3.40%) whereas the ash composition of toasted residue (4.48) is almost similar compares to those in [7] (4.49%). The fiber composition of raw, boiled and soaked residue in the present study was lower to those in reported in [9] and [16] (12% and 14.5% CF respectively) but the fiber content of raw residue is almost similar compares to those reported in [7] (10.12% CF). Similarly, the lipid composition of raw, boiled and toasted residue in present study was higher compares to those reported in [9], [7] and [16] (8%, 10.53% and 12%crude lipid respectively). All the difference may be due to processing method, quality of soy bean and environmental condition where experiment carried out.

The crude protein content of raw residue (27.88% CP) in the present study was higher compares to those reported in [9] and [7] whose reported as (24.00% CP and 25.00% CP respectively) but similar to those reported in [16] reported as (27.00%). The crude protein of boiled (22.83% CP) and toasted (20.83% CP) was lower compares to those reported in [9], [7] and [16] reported as (24% CP, 25%CP and 27%CP respectively). This might be probably because of the different processing. However, the Nitrogen Free Extract composition (NFE) of raw and toasted residue in the present study was lower compare to those reported in [9], [7] and [16] as (38%, 50% and 52% respectively) but the value of boiled residue (51.83%) was higher than those reported in [9] as (38%) and similar to those in [7] and [16] as (50% and 52%).

5. Conclusion

Conclusively, this study showed that the whole soya bean on different processing methods such as raw, boiling, cooking and soaking are essential in nutrients requirements for function, growth and other metabolic activities for fish survival. Likewise, the soya beans by-products (Soya beans bran and Tofu residue) contained appreciable nutrients for fish and other metabolic activities but soya bean offal is partially in protein requirement and higher in energy requirements. Therefore, the processing, re-processing, recycling and utilization of these ingredients help to reduce the cost of feed production and also help to increase the profitability of aquaculture business.

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