International Journal of Food Science and Biotechnology
2022; 7(2): 33-40
http://www.sciencepublishinggroup.com/j/ijfsb
doi: 10.11648/j.ijfsb.20220702.13
ISSN: 2578-9635 (Print); ISSN: 2578-9643 (Online)

Effect of Drying Temperature on the Proximate Composition of Soybean Crude Residue-Base Fish Feed

Saheed Abiola Olaoye[1, *], Olanrewaju Temitope Owoseni[2], Olufunso Olawale Oyegoke[3]

[1]Department of Agricultural and Environmental Engineering, School of Engineering and Engineering Technology, Federal University of Technology, Akure, Nigeria

[2]Department of Agricultural Science, Faculty of Agriculture, Adeyemi College of Education, Ondo, Nigeria

[3]Department of Food Science and Technology, Faculty of Engineering Yabba College of Technology, Yabba Lagos, Nigeria

Email address:

Olaoyesaheed226@gmail.com (S. A. Olaoye), oowoseni@yahoo.com (O. T. Owoseni), funshlinks@gmail.com (O. O. Oyegoke)

[*]Corresponding author

To cite this article:

Saheed Abiola Olaoye, Olanrewaju Temitope Owoseni, Olufunso Olawale Oyegoke. Effect of Drying Temperature on the Proximate Composition of Soybean Crude Residue-Base Fish Feed. *International Journal of Food Science and Biotechnology*. Vol. 7, No. 2, 2022, pp. 33-40. doi: 10.11648/j.ijfsb.20220702.13

Received: April 11, 2022; **Accepted**: May 16, 2022; **Published**: June 30, 2022

Abstract: Soybean crud residue has been a by-product of processed soybean being used as land fill and contributing nuisance to the community. Its 30% protein contain necessitate it recycle into feed, be it animal feed or for human consumption. Soybean crud fish feed was formulated using pearson fish feed formulation. Objective of this research work is to investigate the effect of drying temperature on proximate composition of soybean crud residue base fish feed. It was carried out in Food Laboratory of Department of Agricultural and Environmental Engineering, Federal University of Technology, Akure. Soybean crud residue was obtained from soybeans after the extraction of soymilk, while other component of the feed were bought. Pelletized feed was produced and dried in an oven at different temperature of 40°C 50°C 60°C 70°C and 80°C respectively. Rate of water losses in drying duration of 2 hours 45 minutes at different drying temperatures was realised. Drying rate was at different temperature and time of 50 g samples was obtained, this shows rate of drying and diffusion rate of water in the feed. Proximate composition of feed Moisture Content, Ash, Fat, Fiber, Protein, and Carbohydrate were analyzed using standard method. Protein content varied from 35.55±0.06% at 40°C to 31.80±0.01% at 80°C, lipid content ranged from 2.89±0.01% at 40°C to 2.74±0.03% at 50°C, fiber content ranged between 7.76±0.01% at 60°C to 7.62±0.01% at 40°C, moisture content varied from 9.64±0.00% at 40°C to 7.28±0.02% at 80°C, carbohydrate content varied from 45.67±0.01% at 80°C to 39.36±0.01% at 40°C and ash ranged from 5.19±0.01% at 50°C to 4.67±0.01% at 80°C, respectively. Proximate composition analyzed varied significantly from one another. Best result of proximate composition after drying was obtained at 40°C drying temperatures among all the five temperatures.

Keywords: Soybean, Drying, Oven, Proximate, Protein, Crud-Residue

1. Introduction

Soybean (*Glycine max* (L.) Merrill), is a versatile species of the grain food legume, with high content of protein, fibers, fat and starch for both human and livestock consumption [18]. It is a native of East Asia and perhaps the oldest cultivated temperate legume (3000 BC) in China and long recognized in surrounding countries like Japan, Korea, and Malaysia, where it is a long established cultivated plant (Onwueme and Sinha, 1991). The production of any agricultural produce will have required climatic and soil conditions, be it grain, tuber or vegetable. Soybean has a planting duration of 6 months, mostly between June and October which is monsoon period. Although; according to [11] it can be planted in dry season compare to rice which is monoculture systems. It required temperature range of 15°C – 30°C for it germination; while, it growth and yield temperature range are between 30°C - 33°C [6]. Soy protein is large quantity and good quantity necessitating it use in many food production such as ice cream, bread, milk, beverages and animal feeds [19, 24]. Wet extraction method of soy bean protein has been the most famous method over multiples of decades [39]. It functionality place it in a quintessential position in most animal feed production and for man consumption, much more; laboratory analysis on it water absorption capacity and solubility inclusion with it hydration capacity indicated its protein solubility and ease of digestion [6].

Soybean crud residue (SCR), a by-product of tofu, soymilk or soy protein, discharged as waste into the environment, causing potential havoc because it is highly susceptible to putrefaction [37]. According to [40] raw soybean crud residue SCR spoils quickly, it should be preserved with appropriate means. While drying process by heating is one of the solution to the spoilage problem, thermal drying of soybean crud residue SCR result in loss of its nutritional value and huge energy cost. Amino acids is of high percentage in soybean crud residue indicating it high quality protein content. It is well-documented that SCR contains about 30% protein (dry basis) with good nutritional quality. A superior protein efficiency ratio which shows a potential of low cost vegetable protein for human consumption [11]. Soybean crud residue (SCR) is of better quality than other form of soybean products; for example, the protein efficiency ratio of SCR is 2.71 compared with 2.11 for soymilk but tofu and soymilk have similarity in the ratio of digestible amino acid and total amino acid [36]. According to [12] it is clear that fermented soybean crud residue can only be regarded as a waste component, odor generated from it always constitutes nuisance to the community. Redondo *et al.* (2008) reported that dietary fiber in soybean crud residue (SCR) can reduce blood fat and blood pressure, lower the level of cholesterol in the blood. Also; it could protect against coronary heart disease, and prevent the occurrence of constipation and colon cancer. [28] in their research, reported that maize residue contains high carbohydrate content which can also be mixed with soybean crud residue (SCR) for it nutritional benefit. Conversion of soybean crud residue to useful product is now gaining recognition in Nigeria. [38] in their research supply soybean crud residue to rabbit to evaluate the functionality of protein content in soybean crud on rabbit.

Proximate composition of soybean is largely dominated by protein, fats, carbohydrate, vitamins isoflavones, moisture content, ash, fiber and minerals [10]. It protein is of different degrees in it purity, based on the constituent produced from it, soybean flour has 40% protein soybean protein concentrate SPC ism of 70%, while soybean protein isolate SPI is more than 90% protein [20]. Moisture content of argil-produce could range to over 90% of its composition, it play important role in diffusion of solvent and maintain structure and membrane macro and micro molecules as well as cells in the product [19]. Ash content in soybean was evaluated to be between 6 to 12% since it dependent of drying temperature above 500°C and its specie. This could affect the denaturing of other nutritional component like protein, fat and carbohydrate [4]. Also; processing temperature play a significant role in it deterioration.[34]. Lipid is often referred to as fat or oil synonymously, this is organic substance that can only be soluble in organic solvent such as chloroform, ether etc., but not in water component [6]. Fat is significantly affected by temperature either by denaturing it structures or rancidity, drying temperature or temperature during processing are the two critical area where volumetric variation of soy oil occurs. [20] made similar observation in the heat pretreatment of snake gourde seed for its oil extraction. Carbohydrate is an organic component largely determining functional properties of soybean, it water activity, solubility, absorption and hydration. Dying at high temperature influences structural component of carbohydrate and its digestibility [6].

Fish feed is a major expenditure incur by fish farmers in fish production. Good fish feed management can reduce overall culture cost, improve fish farm environment and ensure healthy growth of fish stock. Fish feed management includes choosing the right feed, using a correct feeding method, calculating the feeding cost and ensuring the cost effectiveness of fish farm, compatibility with the protein requirement of fish [1]. In the total cost of management of fish production, fish feed amount to 60-80% of the total cost. [29]. Leaching of nutritional component of locally formed feed which are sinking feeds [16]. Right selection of feedstuffs and appropriate inclusion level of locally available floating catalysts will achieve positive buoyancy in feeds [31].

Drying is one of the accent processes in food production, it could be for dewatering, dehydrating or treatment. Sun drying is the oldest mode of drying, but not solar drying [30, 35]. Most importantly it is to reduce water content in food and food material to improve it quality and prolong it preservation. Drying practices improve the shelf life of food either for short term storage, middle term storage or long term storage [7]. Soybean crud residue contain about 67% moisture content this make it drying tedious and expensive with the use of conventional dryer [28]. buoyance of soybean crud residue based fish feed was aided with drying of the feed, i.e. it increase duration of staying on water [15]. Drying of fish feed added to the value of the feed by improving the lustra surface and reduce it density. The major challenge of dried feed is during storage where infections and invadement by pest on the storage facility. Oven drying may be one of the good method of drying fish feed since it will prevent infestation during drying [13]. The rate of water loss in drying material is determine by porosity of the material, hardness of the material, drying temperature etc. which is called drying rate [38]. It influence the movement of water molecules within layers of drying material and from region of high concentration to region of low concentration called diffusion [19]. Duration of drying and temperature of drying affect level of drying in drying processes, bone are mostly required for grains and vegetable, but of different degree and duration [21]. These drying parameters are called drying time and drying temperature. Moisture rate of reduction with respect to temperature and time of drying give raise to weight loss this could be called dehydration or dewatering [40]. Proximate composition in agric-material are significantly affected during drying process. Denaturing, dissociating, deterioration and restructuring of the nutritional component at extreme temperatures will occur if drying temperature is not well regulated [38].

2. Materials and Methods

The section covers the materials used for the production of fish feed, the experimental set up, the methods and techniques employed in producing the fish feed prior to drying.

2.1. Study Period and Processing of Soybean

This study was conducted for a period of three month between March 2021 and May 2021. Soybean (*Glycine max* (L.) Merrill) was bought from Oja Oba market Akure in it dry base of about 22 kg mass. It was soaked in distilled water in a black bowl for 12 hours, aiming at turning it to wet base though hydration process. Threshing process took place after soaking to remove the shave, this was done mechanically with the use of threshing machine (NCK-01 HM). The soaked and dehulled soybean was milled with attrition milling machine (09ADWPH2468LI2R). This give raise to a molten soybean, which was shaved to separate the liquid soybean from the residue. The liquid soybeans is often referred to soymilk which was taken away for soymilk and soy- cake preparation. The crud residue was poured into a sack container and well tighten. This tighten sack of soybean crud residue was subjected to dewatering under hydraulic press (OH 937-773-3420). It turn out to be solid component, it was then pulverized by pulverizing machine (SMF500-850). Pulverized soybeans crud residue was sun dried to bone dry for 10 hours at 33°C drying temperature. Proximate analysis was conducted to determine its protein percentage content, It contain 29% protein which was in line with [37] and so many researches that have worked on soybeans and soybeans crud residue. These operation was carried out in the Food Processing Laboratory of Agricultural Engineering Department, Federal University of Technology, Akure.

2.2. Other Component of Soybeans Crud Reside Based Fish Feed

Component of the fish feed are maize 14%, wheat bran 25%, soybeans meal 10%, starch 10%, fish meal 5%, vitamin C 0.3%, methionine 0.4% and antioxidant 0.3%. Soybean crud residue constitutes 35% of the fish feed. This is the proportion of constituents for every kilogram (kg) of fish feed formed. Purchase of these component was in farm support stores, cassava district, road block, Ilesa road, Akure, Ondo State.

2.3. Preparation of Fish Feed

All component of the fish feed were mixed thoroughly and homogenous composition was formed. Mixing was done mechanically with the use of mechanical mixer (JZC 15). Moisture content of feed was increased to wet base from dry bases by adding water, it attained 33% moisture content. This was done to avoid clogging and burning during extrusion to form pellet of fish feed.

2.4. Oven Drying

After pellet formation drying was carried out, it was conducted at five different temperature of 40°C, 50°C, 60°C, 70°C and 80°C in an electric oven in the laboratory.

2.5. Estimation of Proximate Composition

Proximate analysis of feed composition was determined after drying in samples. It was carried out at the central laboratory of Federal University of Technology Akure.

2.6. Determination of Moisture Content in Dried Sample

About 5 gram of dried sample were taken into each known weight basin and weighed in a digital balance, and weighed in a digital balance (Toledo, Switzerland). The samples were oven dried (Memmet 854 Schwabaach) at five different temperature for 2 hours 45 minutes to reduce the moisture content. This method is the conventional method of AOAC [3] on weighing basis, it was used by [17, 26] with slit modification.

$$Mositure\% = \frac{Original\ Weight\ of\ sample - Dry\ weight\ of\ sample}{Original\ Weight\ of\ Sample} \times 100 \quad (1)$$

2.7. Determination of Protein Composition

Protein composition was determined by the method used by micro-kjeldah method [32, 17, 26] with slit modification. A flask was used for the conversion of organic nitrogen to ammonium sulphate by digestion with concentrated sulphuric acid. The digest was diluted, made alkaline with sodium hydroxide and distilled. The liberated ammonia was collected in a boric acid solution and was determined titrametrically. It calculation includes the following.

$$\%\ of\ N_2 = \frac{\%\ of\ N_2(Titration\ reading - blank\ reading) \times streght\ of\ acid \times 0.002 \times \frac{100}{5} \times 100}{Weight\ of\ sample\ taken} \quad (2)$$

The percentage of protein in the sample is noe calculated by multiplying the% of N_2 with an empirical factor.

% of protein =% of total N_2 × empirical factor of fish feed.

2.8. Evaluation of Lipid and Crud Fiber

AOAC method of determining fat was used. About 5 g of the homogenous sample was taken into conical flask and 10 ml of folch reagent (chloroform: methanol = 2:1) were added into the sample and homogenized properly and kept in air tight condition for 24 hours [2]. The solvent form a compound with fat content in the feed and remain in aqueous state. After 24 hours the solution of the flask was filtered in another weighed conical flask through a filter paper. Then these flasks were place in a hot water bath to dry up and reduce the solvent.

After that the flasks were kept into an oven for an hour to get the actual fat content. Then the flasks were weighed in an electronic balance to get the amount of fat content [26, 38].

$$Lipid\% = \frac{\text{Corrected weight of fat}}{\text{Weight of original sample}} \times 100 \quad (3)$$

Determination of Crud Fiber

Crude fiber was determined by following the method of AOAC, 1980. The crude fiber content of feed ingredients was then determined according to the following formula:

$$\text{sscrud fiber} = \frac{\text{weight of crud with original sample} - \text{weight of crud with ashed sample}}{\text{weight of orignal sample}} \times 100 \quad (4)$$

2.9. Determination of Total Ash

Ash content in each feed ingredient was estimated by following incineration method. The toatal amount of ash in the each sample was determined by the following equation.

$$\text{Total ash} = \frac{weight\ of\ crucible\ with\ orignal\ sample - wieght\ of\ crucible\ with\ ashed\ sample}{weighy\ of\ original\ sample} \times 100 \quad (5)$$

2.10. Data Analysis

All experimental result data for moisture (%), dry matter (%), crude protein (%), total ash (%), crude fiber (%), crude fat (%) were analyzed by using a computer program MS Excel and one-way analysis of variance ANOVA and values were sorted as the mean and standard deviation of triplicate determinations, this was followed by Duncan multiple range test (DMRT) at 5% level of significant. This statistical analysis was performed with the support of the computer software SPSS (statistical package for social sciences 20.0 software).

3. Result and Discussion

3.1. Oven Drying

Drying is a process of reducing water content in a substance which is often called dehydration [8]. This involved water losses from the body of drying mater to its surroundings, diffusion process occurs within the mater while convention current carries away the moisture molecules from the surface of the liquid [5]. The rate of water losses is relative to degree of temperature of drying coupled with the duration of drying [23, 9]. In this research we observed that the rate of water loss was significantly affected by temperature of drying. Drying temperature of 40°C has the lowest rate of drying while 80°C has the highest drying rate. Moisture losses was increasing as the drying temperature increases progressively from 40°C 50°C 60°C 70°C to 80°C. The curve of water loss and drying time shows that 40°C dehydration curve gave the steepest, while the gentility of the curves varies as the temperature increases. The factor responsible for this is the drying temperature as being reported by [14] in their research on drying kinetic of sage leaves. Oven dried soybeans residue based fish feed generate a smooth curve for all the temperatures of drying except the sun drying curve. This could be as a result of variation in atmospheric temperature during sun drying. A similar scenario occurred when [25] conduct a research on Effect of Moisture content on the drying rate using traditional open sun and shade drying of fish.

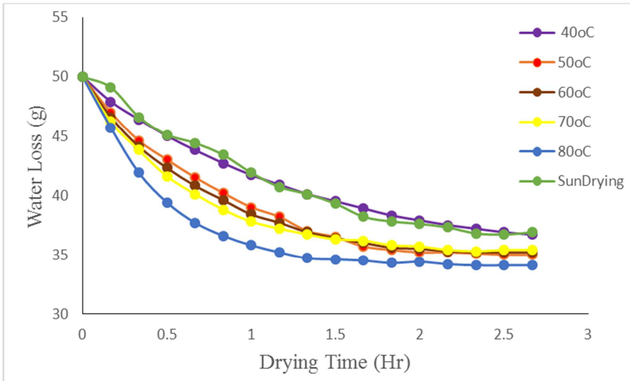

Figure 1. *Water loss in the field at different drying time.*

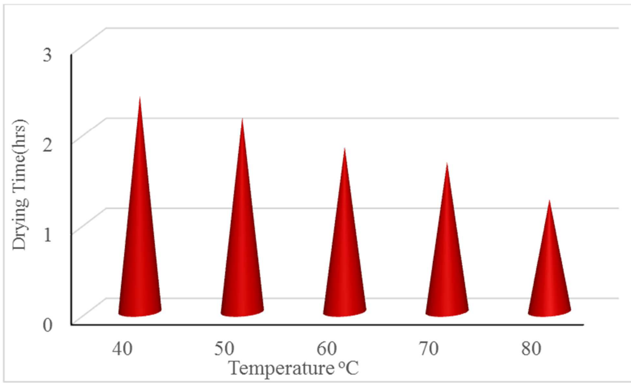

Figure 2. *Drying rate of fish feed at different drying temperature.*

Duration of drying is a function of temperature, air velocity, moisture content and other drying parameters. Drying time decreases as the temperature of drying increases from 40°C to 80°C. The decrease was rapid between 40°C and 60°C, this indicate that there was a constant drying rate. This result was consistent with previously published studies of [5]. Furthermore; it experience drag between 60°C and 70°C, this is an indication that the soybean crud residue based fish feed is attaining bone dry. Drying time between 70°C to 80°C was rapid, it dependent of high drying temperature [23]. The average drying time were 2.45±1.00 (40°C) 2.16±1.00 (50°C) 1.83±1.00 (60°C) 1.66±1.00 (70°C) and 1.25±1.00 (80°C) hr., figure shows the drying rate and its variation base on drying temperature changes, this is in consonance with [38].

Table 1. *Average composition of proximate result of soybeans crud residue based fish feed.*

Temperatuer °C	MoisturContent%	Ash%	Fat%	Fiber%	Protein%	Carbohydrate%
40	9.64±0.00[a]	5.03±0.01[a]	2.75±0.01[a]	7.62±0.01[a]	35.55±0.06[a]	39.36±0.01[a]
50	8.45±0.01[b]	5.19±0.01[b]	2.74±0.03[ab]	7.72±0.00[b]	34.15±0.07[b]	41.68±0.01[b]
60	7.87±0.01[c]	5.04±0.00[b]	2.82±0.01[bc]	7.76±0.01[bc]	33.05±0.06[c]	43.57±0.02[c]
70	7.40±0.00[d]	5.16±0.01[c]	2.83±0.00[c]	7.69±0.01[c]	32.80±0.14[d]	44.09±0.01[d]
80	7.28±0.02[e]	4.67±0.01[d]	2.89±0.01[d]	7.67±0.03[c]	31.80±0.01[e]	45.675±0.01[e]

Data are expressed as mean ± standard deviation same letters in each column indicates the lack of significant difference (p> 0.05).

3.2. Protein Content

Results from this research shows that protein decrease as the drying temperature increase from 40°C, 50°C, 60°C, 70°C and 80°C, the average of the triplicate inclusive of its standard deviation are 35.55±0.06%, 34.15±0.07%, 33.05±0.06%, 32.80±0.14% and 31.80±0.01% respectively. Protein content at different temperature varied from one another. The proximate composition of protein in dried component are usually higher while lower in fresh content. This was reported by [38]. In this case, it was on the contrary, it could be as a result of high dry temperature which lead to the reduction of protein [17] had similar result in their study on drying temperature of fish. Also [27] recoded decrease in protein content as the drying temperature increases. The above discussion was absolutely in concord with our observation that 40°C has the highest percentage of protein while 80°C has the lowest percentage of protein.

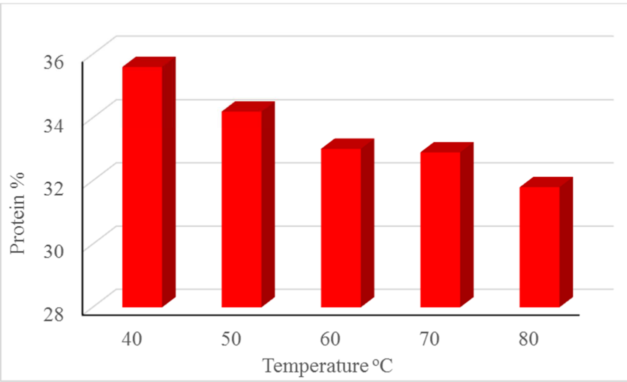

Figure 3. *Protein content in fish feed at different drying temperature.*

3.3. Lipid

Lipid content increases from low temperature to high temperature, based on our observation in this study. Fat quantity drops from 2.75±0.01% to 2.74±0.03% in table 1) as the temperature increase from 40°C to 50°C. Study of [38] had similar observation with decrease of fat from 5.93% to 5.92% in fish drying. Fat content increases from 2.82±0.01% to 2.83±0.00% and 2.89±0.01% as the temperature increases from 60°C to 70°C and 80°C respectively. It was reported in another study of [27] that lipid content varies with temperature as a response to it volume and quantity during drying. [33] made an observation that rancidity may set in in lipid if the drying temperature increase integrally during drying and affect the quality and quality of lipid content. In this research work it was that 40°C has the least lipid content of 2.75±0.01% while 80°C has the highest lipid content of 2.89±0.01%. The range of variation between percentages of lipid content was 0.14%, which is still within acceptable range of lipid content variation. It was corroborated by [17] in their research work on the drying of turmeric.

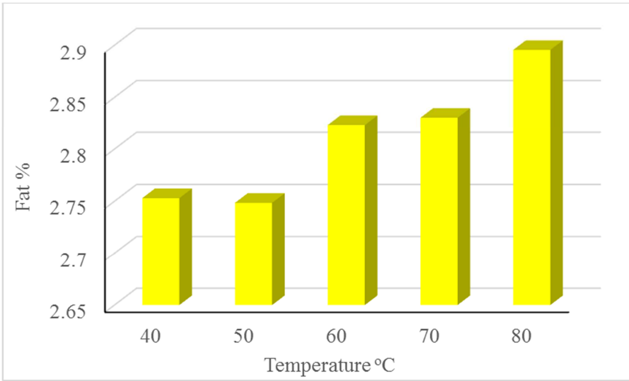

Figure 4. *Fat content in fish feed at different temperature.*

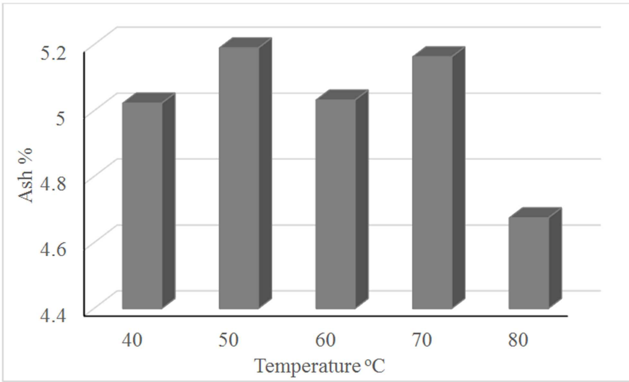

Figure 5. *Ash content in fish feed at different level of drying temperature.*

3.4. Ash

The ash content at 50°C temperature of oven dried soybean crud base fish feed was 5.19±0.01%. In the temperatures of 40°C, 60°C, and 70°C ash content were 5.03±0.01%, 5.04±0.00%, 5.16±0.01% respectively, while that of 80°C drying temperature was 4.67±0.01%. Ash content of soybean crud residue base fish feed varied significantly at different levels of temperatures. This was in consonance with [38] in their report it was stated ash content ranged between 1.4 -21.67% which is still with the range of this study. In another vain, the study [21] in their research work observed that the least amount of ash in *L. rohita* as 1.31%, *Catla catla* 0.93%, C. *cirrhosus* 1.40%, *L. calabasu* 1.02%, *Mystus seenghala* 0.91% and *Wallago attu* 0.72%. This was slitly differ from this study having the least ash amount to be 4.67±0.01% at 80°C of drying temperature.

3.5. Moisture Content

The moisture content soybean crud residue varied as the temperature varied, this variation of drying temperature and moisture content is as inverse variation. Moisture content decreases as the drying temperature increase, 9.64±0.00% of moisture content was observed at drying temperature of 40°C, while 8.45±0.01%, 7.87±0.01%, 7.40±0.00%, and 7.28±0.02 were obtained at drying temperature of 50°C, 60°C, 70°C and 80°C respectively. In the sundry dry of soybean fish feed it observed that moisture content ranges from 10% to 20%, [38] which still in line with this research work. The moisture content may varied as a result of porosity of the pellet feed. It was also suspected that the hardness of the pellet feed during extrusion may be a factor that implead diffusion rate of moisture content from area of high concentration to area of low concentration. More over the compressional force during extrusion process may be responsible for compaction of the feed layer [22].

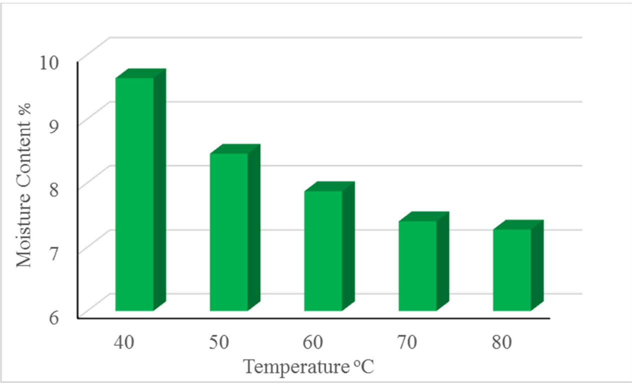

Figure 6. *Moisture content proportion in soybean crud residue base fish feed.*

3.6. Fiber

Fiber content in dried soybean crud residue based fish feed was statistically analyzed, the highest value of fiber was 7.76±0.00 which was obtained at 60°C drying temperature. Lowest fiber content was 7.62±0.01% which was observed at drying temperature of 40°C, fiber content of 7.72±0.01 was observed at drying temperatures of 50°C, 7.69±0.01 at drying temperature of 70°C and 7.67±0.03 at drying temperatures of 80°C. This may be a function of drying temperature varied, inclusion of the thickness and density of feed composition of different sources. [25] reported variations in the amount of fiber in fish dried, *tilapia zilli* has 3.02+0.03 *Clarias geriepinus* 2.61+0.06, *Synodontis ocellifer* 3.62+0.05, *Alestes baremose* 2.91+0.04. This is in close relation with my observation in this research.

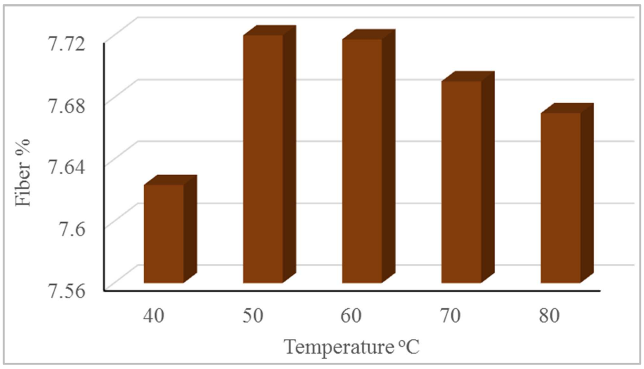

Figure 7. *Fiber percentage in soybean crud residue based fish feed at different level of temperature.*

3.7. Carbohydrate

The carbohydrate of content in this fish feed after drying increases as the drying temperature increases. The increase at each temperature was not absolutely proportional but on the average of all temperatures carbohydrate content was proportional to drying temperatures. The lowest drying temperatures of 40°C has carbohydrate content of 39.36±0.01%, the highest drying temperature 80°C has 45.675±0.01%, 50°C has 41.68±0.01%, 60°C has 43.57±0.02%, and 70°C has 44.09±0.01%. The temperature of gelatinization of feed was 65°C to 105°C which is responsible for the percentage of digestible starch in the feed. Water absorption index, water solubility index are all functional properties that is dependent of rate of gelatinization, all these are performance relying on temperature [28]. Dextrinazation of food content arises based on temperature of high degree being applied during processes. High temperature effect may radiate to other functional properties of the feed.

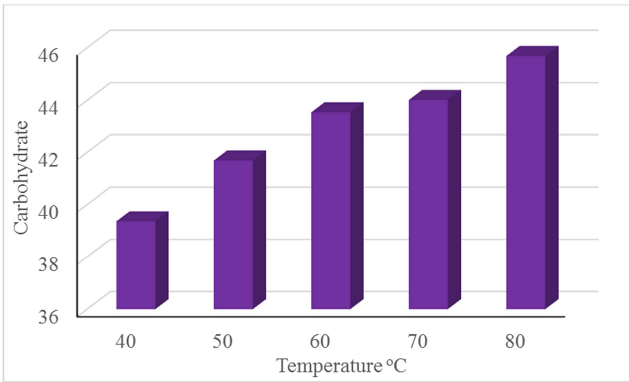

Figure 8. *Carbohydrate proportion in soybean crud residue base fish feed.*

4. Conclusion

This research work has showed a rendition of effect of drying temperatures of soybean crud residue base fish feed on its proximate composition. Efficiency of electrical oven dryer and it optimum drying temperature of drying fish feed formed basically from soybean had been investigated in this research. Drying temperature of 40°C gave the highest percentage of protein content and has optimum performer in other nutritional component, out of other drying temperatures of 50°C, 60°C 70°C and 80°C. Oven drying method of drying is best suitable for drying fish feed, it can be scaled to industrial level from laboratory scale. Nutritional component and physiochemical properties of oven dried feed was high and best for both small and large scale fish production. Industrial usage of this research will enhance productivity and good profit margin for fish feed manufacturer and fish farms as well as job opportunity for workers. Further research work should be done in formulating fish feed from soybean crud residue for other species of fish considering it nutritional potential and also for other better usage for man and animal benefits.

References

[1] Alam, M. S., Kaur, J., Khaira, H., and Gupta, K. (2016). Extrusion and Extruded Products, *Food Science and Nutrition*, vol. 56. pp 132-140.

[2] AOAC. (Association of Official Analytical Chemist) 1990. Official methods of Analysis (15th ed). Inc., Suite, 400, Arlington, Virginia. Vol. 2: 685-1298 pp.

[3] AOAC, 1980. Official Methods of Analysis. 13th Edn, Association of Official Analytical Chemists, Washington, DC., USA.

[4] Arnarson, A. (2019). Soybean 101: Nutition facts and health effects.

[5] Aslı A, Salih K., Alican A. and Selma K., (2019) Effects of Different Drying Methods on Drying Kinetics, Microstructure, Color, and the Rehydration Ratio of Minced Meat, *Multidisciplinary Digital Publishing Institute*, vol. 8, pp. 214-228.

[6] Awuchi, C. G. (2019). Proximate Composition and Functional Properties of Different Grain Flour Composites for Industrial Applications. International Journal of Food Sciences, vol. 2, no 1, pp 43-64.

[7] Balachandran KK. 2001 Post-harvest Technology of Fish and Fish Products. Daya Publishing House, Delhi-110035,, 1-77.

[8] Baslar, M.; Kilicli, M.; Yalinkilic, B. (2015) Dehydration kinetics of salmon and trout fillets using ultrasonic vacuum drying as a novel technique. Ultrason. Sonochem., 27, 495–502.

[9] Bligh EG, Dyer WJ. A rapid method for total lipid extraction and purification. Canadian Journal of Biochemistry and Physiology. 1959; 37: 911-917.

[10] Bogdan S., Aleksandra G., Renata K., and Anna K., (2020) Mineral Composition of Traditional Non-GMO Soybean Cultivars in relation to Nitrogen Fertilization*., Scientific World Journal* pp 15.

[11] Chauhan, C., Zraly, C. B., and Dingwall, A. K. (2013). The Drosophila COMPASS-Like Cmi-Trr Coactivator Complex Regulates Dpp/BMP Signaling in Pattern Formation. *Flybase Refrence Report*, vol. 38 no. 2 pp. 185-198.

[12] Dajanta, K., Apichartsrangkoon, A., and Chukeatirote, E., (2011) Influence of Particle Size on Protein Extractability from Soybean and Okara, *Journal of Microbial and Biochemical Technology,* vol. 3, no. 04, pp. 567-573.

[13] DOF. Jatio Matshaw soptahoo Sankolon. 2018 (in Bengali) Ministry of Fisheries and Livestock, Dhaka, Bangladesh, 2018, 148-149.

[14] Doymaz, I.; Karasu, S. (2018) Effect of air temperature on drying kinetics, colour changes and total phenolic content of sage leaves (Salvia officinalis). Qual. Assur. Saf. Crop. Foods, 10, 269–276.

[15] Enwemiwe, V. N., (2018), Methodology in Production of Local Integrated Fish Meal: Our Affordability in Abraka, Delta State, Nigeria, *International Journal of Advance Research and Publications,* vol. 2, no. 1, pp. 567-578.

[16] Falayi, B. A., Sadiku, S. O. E. Eyo A. A., and Okaeme F. Y., (2003). Beeswax and Lemna Paucicostata Potentialities as Natural Fish Feed Floater, Stabilizer and Preservator. In*: Fisheries Society of Nigeria Conference Proceedings Port Harcourt.* vol. 3, pp. 238-250.

[17] Farzana B. F., Gulshan A. L., Mosarrat N. N., and Mohajira B., (2014) Effect of Sun-drying on proximate composition and pH of Shoal fish (C. striatus; Bloch, 1801) treated with Salt and Salt-turmeric storage at Room Temperature (27° - 30°C). *Journal of Agriculture and Veterinary Science*, Vol. 7, PP 01-08.

[18] Gibson, K. S. and Benson. T. Y. (2005), Ameta-Analysis of The Effect of Soy Protein Supplementation on Serum Lipids, *The American Journal of Cardiology,* vol. 98, no. 5, pp. 633–640.

[19] Hu, B., Chen, Q., Cai, Q., Fan, Y., Wilde, P. J., Rong, Z., & Zeng, X. (2017). Gelation of soybean protein and polysaccharides delays digestion. Food Chemistry, 221, 1598–1605.

[20] Idowu, D. O., S. A. Olaoye, E. O. Owolabi and Adebayo, J. M. 2019. Effect of Hydrothermal PreTreatment on Snake Gourd Seed Shelling. Int. J. Curr. Microbiol. App. Sci. 8 (02): 1848-1858.

[21] Jahan S. N, Chhabi I. J, Samad M. A, (2018) Hossain MI. Comparative study on nutritional quality of sun dried fish and oven dried fish. International Journal of Advances in Science Engineering and Technology. 6 (4): 108- 111.

[22] Kahraman, A. "Nutritional value and foliar fertilization in soybean," Journal of Elementology, vol. 22, no. 1, pp. 55–66, 2017.

[23] Kroehnke, J.; Szadzinska, J.; Stasiak, M.; Radziejewska-Kubzdela, E.; Bieganska-Marecik, R.; Musielak, G. (2018) Ultrasound- and microwave-assisted convective drying of carrots—Process kinetics and product's quality analysis. Ultrason. Sonochem, 48, 249–258.

[24] Matsumiya, K., & Murray, B. S. (2016). Soybean protein isolate gel particles as foaming and emulsifying agents. Food Hydrocolloids, vol. 60, pp. 206–215.

[25] Modibbo. U. U., Osemeahon S. A. and Shagal M. H., and Halilu. M, Effect of Moisture content on the drying rate using traditional open sun and shade drying of fish from Njuwa Lake in NorthEastern Nigeria *Journal of Applied Chemistry.*

[26] Mohammed A., Herbert K. D., Addah W., Regina R and Eva S (2019) proximate components, minerals, amino acids and some anti-nutrients in processed false yam seed meals: Potential benefits for poultry nutrition *Scientific African Elsevier* vol 6 pp. 3406-3421.

[27] Msusa N., Likongwe J., Kapute F., Mtethiwa A. and Sikawa D. Effect of processing method on proximate composition of gutted fresh Mcheni (Rhamphochromis species) (Pisces: Cichlidae) from Lake Malawi, *International Food Research Journal* vol. 4 No 24 pp. 1513-1518.

[28] Olalusi, A. P., and Bolaji O. T., (2014), Dehydration Characteristics of Ogi Produced from Maize and Guinea Corn. *Proceedings of International Conference of the Nigeria Institute of Agricultural Engineers*, pp. 408 – 413.

[29] Olomola, A., (1990), Captured Fisheries and Aquaculture in Nigeria. A Comparative Economic Analysis. In Africa Rural Social Science Series Report No. 13.

[30] Onwueme, I. C., and Sinha, T. D. (1991). Field Crop Production in Tropical Africa CTA. *a Repository of Agricultural Research Outputs* vol. 21, pp. 567-578.

[31] Orire, A. M., and Sadiku S. O. E, (2015), Development of Farm Made Floating Feed for Aquaculture Species, Journal of International Scientific Publications*: Agriculture and Food*, vol. 2, pp. 293-303.

[32] Pearson, D. 1999. Pearson's composition and analysis of foods. University of Reading.

[33] Pier P. D, Carola L, Laura G., Andrea A., and Bruno R. (2019) The Effects of Diet Formulation on the Yield, Proximate Composition, and Fatty Acid Profile of the Black Soldier Fly (Hermetia illucens L.) Prepupae Intended for Animal Feed, *Animal Journal* Vol. 9 Pp 178-205.

[34] Qinhui X., Martin de W., Konstantina K., Remko M. B., and Maarten A. I. (2018) Protein enrichment of defatted soybean flour by fine milling and electrostatic separation, *Innovative Food Science and Emerging Technologies,* vol. 50 pp. 42-49.

[35] Redondo-Cuenca, A., Villanueva-Su´Arez M. J., and Mateos-Aparicio I., (2008) Soybean Seeds and Its By-Product Okara as Sources of Dietary Fibre. Measurement by AOAC and Englyst Methods, *Food Chemistry*, vol. 108, no. 3, pp. 1099–1105.

[36] Shuhong Li, Dan Zhu, Kejuan Li, Yingnan Yang, Zhongfang Lei, and Zhenya Z, (2013), Soybean Curd Residue: Composition, Utilization, and Related Limiting Factors, *International Journal of Food Science and Technology*, vol. 16 no. 8, pp. 423-590.

[37] Song, C., Y. Kitamura, S. L, and Ogasawara K (2012), Design of A Cryogenic CO_2 Capture System Based on Stirling Coolers, *International Journal of Greenhouse Gas Control,* vol. 7, pp. 107–114.

[38] Syeda Nusrat Jahan, Abdur Razzaq Joadder and Saiful Islam (2019) Assessment of proximate composition of oven dried Channa punctatus at three different *temperatures International Journal of Fisheries and Aquatic Studies* vol. 5, pp. 311-314.

[39] Tsugeta, F. Y., and Tuges, W. K., (2010) Citric Acid Production from Okara (Soy-Residue) By Solid-State Fermentation, *Bioresource Technology*, vol. 54, no. 3, pp. 323–325.

[40] Wang, J., Zhao, J., de Wit, M., Boom, R. M., & Schutyser, M. A. I. (2016). Lupine protein enrichment by milling and electrostatic separation. Innovative Food Science & Emerging Technologies, vol. 33, 596–602.