CONSUMER ACCEPTABILITY AND NUTRIENT CONTENT OF WESTWOOD (CIRINA FORDA) LARVA-ENRICHED VEGETABLESOUPS

Abstract

This study evaluated the nutritionalcontentand sensory properties of Okro and Oha soup enriched with Westwood larva (*cirina forda*). The three raw materials were individually processed using standard methods before combining them at different ratios that resulting to 16 samples used for the analysis. The results were compared with two controls; OK9 (100 % Okro vegetable) and OH9(100 % Oha vegetable). The samples were assessed for nutritional contentand sensory properties using standard methods. The result of the proximate analysis for the protein content of Okro sample ranged from 7.67-22.43 %. OK1(larva 60: vegetable 40) Okro vegetable soup had the highest protein content and differed significantly ($p<0.05$) from the rest of the samples of Okro. Protein for Oha sample ranged from 7.05-20.75 %. OH7(larva 45: vegetable 55) had the highest protein content and differed significantly ($p<0.05$) from the rest of the samples of Oha. Total viable count, fungal count and coliform count showed no viable count during storage, total via count for Okro soup ranged from 1.00-5.19 (4 weeks) while the fungal count ranged from 1.11-4.32 (4 weeks), However, for Oha soup 1.16-4.82 (week 4) and the fungal count ranged 1.16-4.82. It showed that bacterial loads kept increasing during this period. Nevertheless, increase presents no risk in terms of food safety. The result of the amino acid showed that all the essential amino acid that were present valine 2.80 ml, leucine 5.10 ml, lysine 11.60 ml, iso-leucine 3.0 ml, threonine 4.07 ml, phenyalanine 8.43 ml, methionine 5.90 ml and histidine 4.30 ml, tyrosine 2.38 ml while non-essential amino acids present are arginine 7.97 ml, cystein 5.40 ml, aspartic acid 7.00 ml, glutamic acid 14.00 ml, alanine 3.84 ml, glycine 5.00 ml, proline 8.00 ml, serine 4.35 ml. The phenomenal study revealed that the addition of larva to these soups intensely boosted the nutritional content of these soup samples as the control, OK9(100% Okro soup) and OH9(100% Oha soup) had least nutritional content when compared to the rest of the samples. OK7 (larva 45: vegetable 55) and OK9(100%) while, OH3(larva 30: vegetable 70) were the most preferred among the other samples and most acceptable. Consumption of westwood larva should be promoted in order to increase dietary variety, nutrient intake, and general human health.

Keywords:Cirina forda (Westwood) Larva, Nutrient Composition, Consumer Acceptability Vegetable Soups, Dietary Diversity.

Introduction

Insectivory, or the human consumption of insects, is a practice that is recognized worldwide, but its prevalence and the types of insects consumed can vary based on location, cultural norms, and local myths (Johnson, 2010). In many developing countries, edible insects are a staple food source (Ramos-Elorduy, 2005). While they are occasionally used as emergency sustenance during times of famine, they are more commonly consumed regularly throughout the year or during certain seasons as a delicacy or soup ingredient (Alamu et al., 2013).Animal protein is not always a reliable source of protein (FAO, 2009). The importance of insect consumption cannot be overstated given the thousands of species that form a significant part of the human diet. Without considering this, our understanding of human dietary history would be incomplete.

Cirina forda is an edible insect belonging to the class Insecta, order Lepidoptera, and family Saturniidae. It is the only member of its family found in Africa. This insect can be harvested from the shea butter tree (Vitellaria paradoxa), an economically important tree in the savanna belt that belongs to the family Sapotaceae. This tree is also the only host for Cirina forda in Nigeria and throughout West Africa. The larvae of Cirina forda are considered pests to shea butter trees as they burrow into the soil at the base of the tree to pupate. However, in parts of Western Nigeria, these larvae are a popular source of protein in many rural African diets (Ande, 2002).

Poverty is often the main barrier to food access, with rural areas and agricultural sectors experiencing higher rates of poverty. The larva of Cirina forda is highly nutritious, rich in tryptophan and has a well-balanced amino acid profile making it an excellent source of protein. Its high ash content indicates it is also rich in minerals (Yohanna et al., 2014). It contains essential minerals such as sodium, calcium, iron and potassium which are often lacking in most animal and plant protein sources (Omotoso, 2006).Many other edible insects including wasps, grasshoppers, spiders, bees, beetle grubs, termites, crickets, caterpillars, ant brood (pupae and larvae), winged insects and various aquatic insects form part of dietary components in several cultures. They contribute significantly to protein, fat, vitamin and mineral requirements in diets (Amadi et al., 2016; Payne et al., 2016).

As global food demand continues to rise with population growth, finding ways to meet this demand remains a critical challenge. In many African countries like Zambia and Tanzania, consuming dried caterpillar flour has become a strategy to combat malnutrition among children, pregnant women, nursing mothers and anemic patients due to its high protein content and rich mineral content particularly iron and calcium.

Westwood larva - also known as mealworms - can be an excellent ingredient for soup! They are a sustainable protein source that is high in nutrients like protein, calcium, iron, and vitamin B12. They have a mild, nutty flavour that pairs well with a variety of soups, from tomato to mushroom to chicken noodle. However, they can add a bit of interesting texture to the soup. Many people find them quite tasty and nutritious.Westwood's nutritional value benefit has been indisputable (Ande, 2002). Nevertheless, larvae would be a better source of macronutrients, while the last option gives a superior escort of minor components (Ande, 2002). It has been advised that prepupae may not be great for hypertensive patients because of its fundamentally higher sodium content (Ande, 2002). Westwood larvae has likewise ended up being a superior wellspring of potassium, magnesium and calcium when contrasted and other food bugs and a few famous wellsprings of mineral supplements. Minor components, for example, Zinc, Copper and Manganese likewise happen in generally higher amounts in Westwood larvae (Ande, 2002). The eatable larvae of Cirina forda bug have wide worthiness as a food source, and furthermore fills in as a significant thing of business in such Nigerian states like Kwara, Kogi, Bayelsa, Niger and Kaduna where it has turned into the most significant and attractive bug (Ande, 1991).

Insectivory, the non-timber forest products are a very important practice of eating insects, is a food resource that forest resource playing crucial roles in human diets remedies both primitive and contemporary food, particularly in making the diets more balanced and traditions (Latham, 2001 and DeFoliart, 2002). The larva of the pallid emperor moth, are found in Nigeria, Ghana, Zimbabwe and South Africa etc. Westwood larva is heavily consumed in Nigeria (Amatobi, 2007). Caterpillars from butterflies are protein source and several tribes across the world consume moths. These African countries includes the Pedi of South Africa, the Bisa of Zambia, the Tiv of Nigeria, the Nanti of the Amazon, the Amacimbi of Zimbabwe and the Aka pygmy of Central African rainforest (Mbata et al., 2003). The use of insects as human food (entomophagy) is widely practiced especially in developing countries. Locusts, grasshoppers, termites, flying insects and caterpillars are insects that are consumed, From May to June, the eggs are found on the host plants and the larvae from June to August every year. The caterpillars are either pushed inside out with a thin stick or punctured and the contents squeezed out. Frequently, and especially if large quantities are harvested, they are boiled and dried out in the sun and stored for later use or sold in the local markets. Insects have played an important part in the history of human nutrition in Africa, Asia, Australia and the Americas (Jongema, 2015). Larvae are normally eaten raw, roasted or dried as snacks or an essential part of vegetable soups which serve as an ingredient (Omotosho, 2006). In countries with lower monetary income, insects remained a part of a diet and even considered as a delicacy, for example, palm weevil (Kelemu et al., 2015). In line with this, the socio-economic aspect of accepting insects as food is a somewhat unexplored area of research. Apart from being reared for economic purposes, they have high nutritional value and are prominent in some cultures around the globe, especially as a special treat and replacing diet in periods of food scarcity.

Aim and Objectives of the Study

The aim of the study was to examine the nutrient composition, and consumer acceptability of Cirina forda (Westwood) larva-enriched vegetable soups.

The Specific Objectives of this research were to:

1. evaluate the nutrient content of the canned vegetable soup, enriched with Westwood larva.
2. assess the consumers' acceptability of the canned vegetable soup, enriched with Westwood larva.

Justification of study

The study of the nutrient content, proximate analysis, sensory evaluation and the microbial loads of this product is to create an avenue for the use of edible insect for vegetable soup, where or when there is an unavailability or insufficient of animal protein. They exact nutritional potential comparable to that of meat and fish (De Foliart, 1992) and are habitually welcomed as a substitute source of protein to animal meat. *Cirina forda* (Westwood) larvae, as well as other edible insects, had been reported to be very nutritious, widely acceptable and commonly eaten in Nigeria. Its supply is almost a gift by nature, and it could serve as a reliable reserve of protein, calcium, iron and zinc with a promising potential in reducing micronutrient malnutrition.

Statement of the Problem

Cirina forda is a remarkably underutilized proteinaceous food, despite its exceptional nutritional value. While meat and fish remain the most widely accepted sources of protein, *cirina forda* enrich impressively high protein content. Incorporating this protein-rich ingredient into soups and stews can elevate the nutritional value and serve as a fantastic substitute for meat and fish. Moreover, exploring the vast potential of *cirina forda* as a protein source can open up limitless opportunities, enabling us to upscale production and provide access to this valuable resource for populations in rural areas who might otherwise suffer from protein deficiencies. There is a growing concern about the lack of protein in the diets of people living in poverty and the associated health consequences. People who are unable to afford adequate amounts of protein-rich foods are at risk for developing diseases such as kwashiorkor, a form of malnutrition caused by a lack of protein. Protein deficiency can also lead to other serious health issues such as stunted growth and cognitive impairment. Without access to protein-rich foods, people living in poverty may suffer from a variety of health issues that can have lasting consequences. The cost of animal protein is a significant barrier for many people living in poverty, as it can be prohibitively expensive. Insects, on the other hand, can provide a sustainable and affordable source of protein. Many insects, such as crickets and mealworms, have high protein content and can be farmed and harvested at a low cost. However, insects can be a source of micronutrients, such as iron and zinc. While the idea of eating insects may be met with resistance in some cultures, they have been a traditional food source in many parts of the world.

Significance of study

The findings of this study will redound to the benefit of the society that edible insects play an important role when animal protein is not available or enough. Also, edible insects are rich in potassium, sodium and calcium which are essential minerals lacking in most animal and plant protein sources.

Material and Methods

Source of raw material

The *Cirina forda* larvae for this analysis were sourced from two Local Government Areas in Anambra State Nigeria namely Oba and Okija and were carefully inspected for wholesomeness and selected for the analysis. The chemical analysis of the samples was carried out in Food Science and Technology Laboratory, of the Nnamdi Azikiwe University, Awka. Also, the microbial evaluation of the oven-dried*Cirina forda* was carried out in the Microbiology Laboratory, Nnamdi Azikiwe University Awka.

Research design

Two different types of vegetable soups were produced using simplex lattice design from Design Expert 12 statistical software. The design key is shown inTable 1 each of the vegetables was combined with the insect larva at different ratios as shown in Tables 2 and 3 for Okro and Oha respectively.

Table 1: Key depicting independent and their level in Okro soup

Mixture component	low	high
Cirina forda	30	70
Vegetable (Okro or Oha)	40	60

Table 2:Research design for Okro soup.

Run	A: larva g	B: Okro g
OK1	60	40
OK2	45	55
OK3	52.5	47.5
OK4	30	70
OK5	37.5	62.5
OK6	60	40
OK7	45	55
OK8	30	70
OK9	50	50

Table 3: Research design for Oha soup.

Run	A: Larva g	B: Oha g
OH1	30	70
OH2	45	55
OH3	30	70
OH4	45	55
OH5	37.5	62.5
OH6	60	40
OH7	60	40
OH8	52.5	47.5
OH9	50	50

Production of vegetable soups

Water was used to wash the vegetables leaves to remove sand and pebbles and then one hundred grams (100 g) of oven dried *Cirina forda* larvae was grinded and measured. The grinded sample will be divided into two portions for the preparation of Oha soup, and Okro soup.

Production of okro *Cirina forda larvae* enriched soup

A pre-weighed stainless-steel pot was placed on a cooking gas. Then, (40 ml) of palm oil was added and allowed to fry for 1minute on low heat. Exactly (2 g) Pepper and (2 g) onions was added and allowed to fry for 1minute. Approximately (0.5 g) of salt and 1cube of seasoning cube (0.5 g) was added to taste and then (30 g) of *Cirina forda* larvae added too. Exactly (50 ml) of water was added to the content in the pot and allowed to boil for 5minutes on low heat, then followed by the addition of washed (20 g) of sliced *Telfairia occidentalis* (Oha leaf) and was allowed to steam for 1 minute. The cooking pot was removed from the cooking gas, allowed to cool. The pot and its contents were weighed to determine the yield.

Production of Oha *Cirina forda larvae* enriched soup

A pre-weighed stainless-steel pot was placed on a cooking gas. Then, (40 ml) of palm oil was added and allowed to fry for 1 minute on low heat. Exactly (2 g) Pepper and (2 g) onions was added and allowed to fry for two minutes. Approximately (0.5 g) of salt and 1 cube of seasoning cube (0.5 g) was added to taste and then (30 g) of *Cirina forda* larvae was added. Exactly (50 ml) of water will be added and (20 g) of blended cocoyam added to the content in the pot and was allowed to boil for five minutes, followed by the addition of (40 g) of sliced *Pterocarpus mildraedii*, (Oha) leaves, and was allowed to steam for 1minute. The cooking pot was removed from the cooking gas and allowed to cool. The pot and its content were weighed to determine the yield.

Sensory evaluation of the vegetable soups.

The vegetable soups evaluation was carried out at the Department of Food Science and Technology laboratory, Nnamdi Azikiwe University Awka. A panel consisting of 25 untrained panelists drawn within the University, was the staff and the final year students, who had eaten or known *Cirina forda* larvae before and were willing to participate. The soup samples were rated on the 9-point hedonic scale in which the degree to which a product is relished was expressed as like extremely (9), like very much (8), like moderately (7), like slightly (6), neither like nor dislike (5), dislike slightly (4), dislike moderately (3), dislike very much (2), dislike extremely (1). The panelists were required to observe the sample, taste, and score based on colour, taste, aroma, texture and overall acceptability. The panelists were provided with water to rinse their mouths in between the sample evaluation and were instructed to rinse their mouths with water before tasting another sample.

Statistical Analysis

The data collected from the chemical analysis of the *cirina forda,* and vegetable samples was analyzed using SPSS software version 23. Significant difference among the samples was detected using LSD and Duncan multiple range test at p=0.05. However, the design expert version 23 was used to carry out the regression analysis and response which presented model adequacies were fitted into models. SPSS version was used to carry out the correlation between the Observed and Predicted values of the response.

Fig 1: Okro soup and 'Oha' soup

Results and Discussion

Proximate evaluation of larva-enriched soups.

Simple lattice Design was used to evaluate the effect of the process variables (vegetable and larva) on the shelf stability and nutritional content of Okro and Oha vegetable soups enriched with *cirina forda* larva.

Moisture content: The moisture content of the Okro vegetable soup sample was analyzed and the results are presented in Table 4. The findings revealed that the moisture content of the Okro vegetable soup sample ranged from 34.71- 43.51%. This study showed that moisture content value was lower compared to the value obtained by Adepoju (2020) where moisture content value of 77.14% was reported for their soup sample. In relation to the moisture content values of the Okro samples 1 (60g larva: 40g vegetables) and sample 6 (60g larva: 40g vegetable) did not show significant differences ($p>0.05$) in terms of moisture content. However, other samples are significantly different. It is worth noting that sample 9, which consisted of 100% Okro and served as the control in this study, had the highest moisture content among all the samples. This suggests that the Okro vegetable soup sample with no larva enrichment had a higher moisture content compared to the other samples with larva enrichment. However, High moisture content in soup can affect its taste, texture, and overall quality. The soup may become watery and lose its thickness and richness. This can be due to excess water or broth added to the soup, or if the vegetables or meats used in the soup release too much liquid during cooking. High moisture content in Okro soup can also affect its shelf life. Bacteria thrive in moist environments, and a soup with high moisture contents can spoil quickly if not stored properly.

$$Moisture\ content = 34.70A + 41.92B + 3.53AB \qquad (1)$$

The mathematical model for the moisture content represented in Eq. 2, shows that the relationship between the moisture content and the amount of each ingredient (larva and vegetable) in the soup. The coefficients for larva and vegetables are positive, which means that the amount of moisture increases as the amount of each ingredient increases. The interaction coefficient (larva and vegetable) is also positive, which means that the effect of the two ingredients on moisture is additive.

Table 4.Proximate composition of Okro soup enriched with insect larva

Sample	Moisture	Ash	Fiber	Fat	Protein	Carbohydrate
OK1	$34.77^{h} \pm 0.02$	$6.87^{a} \pm 0.02$	$2.92^{b} \pm 0.03$	$11.77^{a} \pm 0.03$	$22.43^{b} \pm 0.00$	$21.23^{d} \pm 0.07$
OK2	$39.51^{e} \pm 0.01$	$5.81^{d} \pm 0.01$	$2.95^{b} \pm 0.02$	$10.91^{c} \pm 0.01$	$20.18^{e} \pm 0.00$	$20.66^{f} \pm 0.01$
OK3	$37.05^{g} \pm 0.05$	$6.07^{c} \pm 0.11$	$2.94^{b} \pm 0.00$	$10.94^{b} \pm 0.02$	$22.00^{c} \pm 0.00$	$21.01^{e} \pm 0.16$
OK4	$41.82^{c} \pm 0.02$	$4.17^{e} \pm 0.02$	$2.66^{c} \pm 0.01$	$10.03^{e} \pm 0.04$	$16.57^{g} \pm 0.01$	$24.74^{b} \pm 0.04$
OK5	$40.77^{d} \pm 0.01$	$6.15^{b} \pm 0.01$	$3.01^{a} \pm 0.02$	$10.16^{d} \pm 0.00$	$17.33^{f} \pm 0.00$	$22.55^{c} \pm 0.03$
OK6	$34.71^{h} \pm 0.01$	$6.85^{a} \pm 0.00$	$3.04^{a} \pm 0.06$	$11.76^{a} \pm 0.00$	$22.44^{a} \pm 0.00$	$21.22^{d} \pm 0.05$
OK7	$39.04^{f} \pm 0.05$	$5.86^{d} \pm 0.02$	$2.95^{b} \pm 0.00$	$10.88^{c} \pm 0.01$	$20.20^{d} \pm 0.00$	$20.65^{f} \pm 0.02$
OK8	$42.08^{b} \pm 0.10$	$4.00^{f} \pm 0.00$	$2.68^{c} \pm 0.00$	$10.00^{e} \pm 0.00$	$16.15^{h} \pm 0.01$	$24.73^{b} \pm 0.4$
OK9	$43.51^{a} \pm 0.02$	$2.95^{g} \pm 0.04$	$2.95^{g} \pm 0.04$	$7.67^{f} \pm 0.03$	$7.16^{i} \pm 0.00$	$36.74^{a} \pm 0.08$

Values of Table 4 are ± standard deviation of three (3) replicates.

Value in the same column bearing different subscript differed significantly ($p<0.05$)

Keywords

OKI = 60:40 of larva and okro;

OK2 = 45:55 of larva and okro

OK3 = 52.5:47.5 of larva and okro

OK4 = 30:40 of larva and okro

OK5 = 37.5:62.5 of larva and okro

OK6 = 60:40 of larva and okro

OK7 = 45:55 of larva and okro

OK8 = 30:70 of larva and okro;

0K9 = 100g of okra

Table 4shows proximate composition of Okro vegetable enriched with *cirina forda* the ideal equation showing the response variable as a function of the independent variable.(Process variables) is presented below

$$Y = b_1A + b_2B + b_{12}\,AB + b_{11}A^2 + b_{22}B^2 + e \qquad (2)$$

Where y = Response parameter

$B_{1\text{-}22}$ = Coefficient of A and B squares and interaction

A = Larva

B = Vegetable

C = Estimated error

This means that the moisture content increases when both A and B are increased. The R^2 adj of the moisture content is 0.9972%, it equally shows how fit a model is, it also indicates that the model explains appropriately 90% of the variance in moisture. A CV score of 4.7% suggests that the data is low level and quite near to the mean.

Table 5 Correlation of the predicted and Actual value of the moisture content of Okro soup

Predicted	Observed
41.9236	42
41.9236	34.7
40.781	40.77
39.1968	39.5

39.1968	39.03
37.171	37
34.7036	34.77

Table 5 shows the Pearson correlation coefficient is a measure of the linear relationship between two variables. In this case, the r value is 0.503, which indicates a moderate correlation. This means that there is a relationship between the predicted and observed moisture, but it is not a strong relationship. The p-value associated with the r value is 0.249, which is greater than 0.05. This means that there is a possibility that the observed correlation is simply the result of random chance. It is a moderate, positive correlation that is not statistically significant.

Ash content

Table 4 shows that the ash content of Okro vegetables was evaluated, and the result was presented in Table 4 The scientific discovery revealed that the ash content of samples ranged from 2.95-6.87%. This investigation of ash content was higher, collate to the value obtained by Adepoju (2020) where the ash content value is 1.35% was reported for their soup sample. With reference to the ash content of Okro soup samples, the samples varied significantly from each other. Sample 1 (60g larva: 40g vegetable) and sample 6(60g larva: 40g vegetable) did not show significant difference (p>0.05) with regards to ash content, while sample 2 (45g larva: 55g vegetable) sample 7 (45g larva: 55g vegetable) are not significantly different. However, other samples are significantly different. It is to be observed that sample 9 consisted of (100%) okro and served as control in this research, had the lowest ash content among all the sample. This implies that the okro vegetable soup sample with no larva enrichment had the lowest ash content compared to the other samples.

Comment [M1]: Add 'ed' and remove 's'

Comment [M2]: Remove

Comment [M3]: Remove

$$Ash\ content = 6.86A + 4.08B + 1.45AB - 8.20(A - B) + 7.05AB(A - B)^2 \quad (3)$$

The mathematical model for the ash content of okra soup is presented in Eq. 3, that the proportions of each ingredient in the soup are related to the ash content using this equation. The coefficients for larva and vegetable are positive, similar to the moisture equation, which indicates that when the amount of each element is increased, the ash content rises. Positive AB coefficients indicate an additive influence on ash. The AB (A-B) and AB (A-B) 2 coefficients, on the other hand, are negative, pointing to a curvilinear influence. In other words, the ash content initially rises, then falls, and then rises again as the amount of one ingredient is increased while the amount of the other is decreased. The R^2 adj of the ash content is 0.9989%. It also shows that almost 90% of the variance in moisture is explained by the model. A CV score of 0.4738, means that the variability in fiber content is relatively low.

Table 6: Correlation Predicted and observed value of the Ash content of Okro soup.

Predicted	Observed
4.085	4
4.085	4.17
6.15	6.15
5.835	5.86
5.835	5.86
6	6
6.86	6.24333

Table 6: shows the correlation between predicted ash and observed ash was strong, with an r value of 0.976. This shows there is a strong linear relationship between the two variables. However, the p-value of 0.000 indicates that the correlation is statistically significant. This means that the correlation is unlikely to be due to chance. It also states that the correlation is positive, meaning that as the predicted ash increases, so does the observed ash. In other words, these two variables tend to move in the same direction.

Fiber content

From table 6, the fiber content of the Okro vegetable soup sample ranged from 2.66-3.04% with Sample 6(60g larva: 40g vegetable) having the highest value and sample 4(30g larva: 70g vegetable) having the lowest fiber content. Table 6 shows that samples with the same subscript do not differ from each other significantly (p>0.05) while samples with different subscript differed significantly from each other (p<0.05). These studies of fiber content value were slightly low, compared to the value obtained by Amao *et al.* (2010) in their research titled "Effect of Westwood meal on the laying performance and egg characteristics of laying hen in tropical environment. The sample enriched with Westwood was slightly higher than the control sample. This could be due to the variation in food ingredients, Westwood is a reliable source of fiber. It contains about 3 grams of fiber per 100g of serving Gill *etal.* (2021) Fiber is an essential nutrient that plays a crucial role in maintaining digestive health. It helps to regulate bowel movement, prevent constipation, and reduce the risk of colon cancer.

$$Fiber\ content = 2.96A + 2.69B + 0.5443AB \quad (4)$$

The mathematical model for the fiber content of okra soup is presented in Eq. 4, shows that the positive coefficients for ingredients larva and vegetable indicate that fiber content rises as ingredient amounts rise. Additionally positive is the AB coefficient, which suggests that fiber is affected in an additive manner. Since there are no quadratic terms in this equation, the relationship between the two components and fiber is linear. The R2 adj of the fiber content is 0.8672%. It also shows that almost 80% of the variance in fiber is explained by the model. A CV score of 2.03%. This means that the variability in fiber content is relatively small, compared to the average fiber content. It's a good indicator that the measurements are accurate and precise.

Table 7: Correlation Predicted and observed value of the fiber content of Okro soup

Predicted	Observed
2.68866	2.66
2.68866	3.03
2.8585	2.94
2.96029	2.95
2.95977	2.94
21	2.92
21.1433	3.03

Table 7 shows the correlation between fiber predicted and fiber observed showed that the Pearson correlation coefficient is -.530. This negative correlation indicates that as fiber predicted increases, fiber observed decreases. The correlation is statistically significant, meaning that it is unlikely to have occurred by chance. However, this means that as the predicted fiber content of the soup increases, the actual fiber content of the soup decreases. There could be a reason for this, such as loss of fiber during cooking or the predicted fiber values being inaccurate.

Conclusion

The study revealed that Okro and Oha soup enriched with Westwood larva can compete favourably with Okro and Oha soup produced with fish or meat. Analytically, these combinations had a significant effect on the nutritional content, microbial load, amino acid profile, organoleptic and the general acceptability of Okro and Oha soup. *Cirina forda* larva is very rich in protein, high in fat and essential amino acid. The composition of the larva's amino acids revealed that it had an excellent balance of all the required amino acids for human growth, making the protein present in the larva a complete protein with great biological value that is also of animal origin. Fat content of the insect larva contained showing that it can serve as a good source of healthy fat that is fit for human consumption for promotion of good health, it is believed that the consumption of the insect larva, either as snack or in vegetable soups is very safe and will promote quality nutrient intake by consumers.The *Cirina forda* larva-enriched soups were preferable to the plain vegetable soups. The most nutritious soup was Okro soup with *Cirina forda* larvae added. However, out of all the soups, it had the highest nutritious content. Vegetable soups with *Cirina forda* in them taste better and had more nutrients, promoting the consumption of eating these insects should be encouraged. In order to increase the nutritional diversity of the populace in the areas where the insect larva is easily accessible, it should also be encouraged to make this insect larva more widely consumed. This will aid in promoting the consumption of high-quality protein and essential amino acid by the people living in the host community and help fight protein and micronutrient deficiencies, boosting overall health. Consuming it might help prevent the host tree from going extinct as a result of human activity.

Recommendations

From this study, it was evident that Okro and Oha soup can be boosted with Westwood larva and therefore it is suggested that:

1. More experiment should be carried out on vegetable soups to identify the microorganism found on the soup during the microbial analysis.

2. Further experiments should be conducted to evaluate the effect of different insect species on the shelf stability and nutritional content of soup.

References

Alamu, O., Amao, A., Nwokedi, I., Oke, O. &Lawa, I. (2013). Diversity and nutritional status of edible insects in Nigeria. *International Journal of Biodiversity and Conservation*, 5(4); 215-222. Doi: 10.5897/IJBC12.121

Amadi, E. & Kiin-Kabari, D. (2016). Nutritional composition and microbiology of some edible insects commonly eaten in Africa, hurdles and future prospects: *A critical review.*

Amatobi, C. (2007). Arthropod pests of crops in Nigeria: General biology, natural enemies and control. P.A. Ndahi Printing, Zaria – Nigeria", *Journal ofAnnual Review of Entomology,* 52 (1), 57-80. DOI: 10.1146/annurev.ento.52.110405.091337.

Ande, A. T. (1991). Some aspects of the biology of *Cirina forda* (Lepidoptera: Saturniiidea) PhD Thesis Department of Biological Sciences, University of Ilorin, Nigeria". *International Journal of Tropical Insect Science,* 18(3), 177 - 181. DOI: 10.1017/S1742758400023377.

Ande, A. T. (2002). Comparative studies of the mineral composition of processed larvae and prepupae of Cirina forda Westwood (*Lepidoptera: Saturniidae*). *Journal Science Focus*, 4: 11-13.

DeFoliart, G. R. (1992). Insect as human food. *Journal ofGene DeFoliart Discusses Some Nutritional and Economic Aspects,* 11(5), 395-399. Doi: 10.1016/0261-2194(92)90020-6.

Defoliart, G. R. (2002). The human use of insects as a food resource: a bibliographic account in progress". *Journal of Insects as Food and Feed.* 1(1), 1-2. DOI:10.3920/JIFF2015.x001

FAO, (2009). Food security and agricultural mitigation in developing countries: Options for capturing synergies. Rome, Italy". www.fao.org/docrep/012/i1318e/i1318e00.pdf

Johnson, W. D. (2010).Quantifying evolutionary potential of marine fish larvae: Heritability, selection, and evolutionary constraints". *Evolution International Journal of Evolution,* 64(9), 2614-2628. Doi: 10.1111/j.1558-5646.2010.01027.x.

Jongema, Y. (2015). World list of edible insects. Laboratory of Entomology. Wageningen University and research.

Kelemu, S., Niassy, S., Torto, B., Fiaboe, K., Affognon, H., Tonnang, H. & Ekesi, S. (2015). African edible insects for food and feed: Inventory, diversity, commonalities and contribution to food security. *Journal of Insects as Food and Feed*, 1(2), 103–119. Doi:10.3920/jiff2014.0016.

Latham, G. (2001).The importance of understanding and changing employee outcome expectancies for gaining commitment to an organizational goal. *Personnel Psychology*, 54(3), 707–716. Doi 10.1111/j.1744-6570.2001.tb00229.x

Mbata, K. &Chidumayo, E. (2003).Traditional value of caterpillars (Insecta: Lepidoptera) among the Bisa people of Zambia.*International Journal of Tropical Insect Science,* 23 (4), 341- 354.19 September 2011.

Omotoso, T. (2006). Nutritional quality, functional properties and anti-nutrient compositions of the larva of *Cirina forda* (Westwood) (Lepidoptera: Saturniidae). *Journal of Zhejiang University Science B.* 7(1); 51–55. Doi: 10.1631/jzus.2006.B0051.

Payne, C., Scarborough, P., Rayner, M. &Nonaka, K. (2016). "Are edible insects more or less 'healthy' than commonly consumed meats?Acomparison using two nutrient profiling models developed to combat over- and undernutrition". *European Journal of Clinical Nutrition*, 70, 285–291. Doi:10.1038/ejcn.2015.149.

Ramos-Elorduy, J. (2005) "Insects: A hopeful food source". In: G. M. Paoletti, Ed., Ecological Implications of Mini livestock (Potential of Insects, Rodents Frogs and Snails)" *Science Publishers, Inc., Plymouth*, 262-292.

Yohanna, P., John, O., Simon, S., Bukar, N., Mohammed, T. &Helmina, A. (2014). "Fatty acid and amino acid profile of Emperor moth caterpillar (*Cirina forda*)". *American Journal of Biochemistry,* 4 (2); 29-34.