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Research Article

Amino Acid Profile and Phytochemical Screening of Fermented Condiment (Ogiri-igbo) Sold in Anambra State, Nigeria

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Abstract

Quality analysis of selected local fermented condiment (Ogiri-igbo) purchased from sellers in Anambra State, Nigeria were determined using standard methods of analysis. Quality analyses determined in the Ogiri samples were amino acids and phytochemicals. The selected local fermented condiment ogiri samples were purchased from different markets in Anambra State comprising of Eke Uli, Nwofor Uruagu, Ifedigo and Eke-Ichi markets. Amino acids analysis of the Ogiri samples revealed the presence of leucine, lysine, isoleucine, phenylalanine, phenylalanine, tryptophan, valine, methionine, proline, arginine, histidine, cystine, alanine, glutamic acid, glycine, threonine, serine and aspartic acid. Ogiri sample from Eke-Uli was highest in major amino- acids acids comprising of lysine 7.26g/100g, Phenylalanine 7.26g/100g and tryptophan, 1.32g/100g, valine 5.03g/100g, methionine, 1.44g/100g, histidine, 3.53 g/100g and aspartic acid 10.81g/100g. Biotive active phytochemical compounds in the form of Catechin, Apigenin, Genistein, Ellagic acid, Daidzin, Catechin, Apigenin, daidzin, butenin, Naringenin, luteolin, kaempferol, epicatchin, epidallocatechin, epigallocatechin, Quercetin, Gallocatechin-3, Robinetin, myricetin, nobiletin, and Artemetin were found in the Ogiri samples with ogiri purchased from Eke-Uli markets having the highest level of phytochemical compounds. From the study the amino acid of the local fermented condiment Ogiri selected in Anambra State, showed that the Ogiri sample from Eke-Uli was highest in major amino- acids. The fermented Ogiri selected in Eke-Uli, is recommended due to the high amount of amino acid and phytochemical compositions.

Keywords

Fermented Condiment, Ogiri, Seasoning, Castor Seed

1. Introduction

Fermented condiment (Ogiri) has been in use from time immemorial to impact or improve food flavour and acceptability among differ people with little knowledge of its nutritional and medicinal benefit [14]. Food plants are the most important dietary sources for meeting the nutritional needs of majority of the population in Nigeria [33]. It was reported that in spite of the variety and diversification to diets, malnutrition would only be curbed if indigenous food production, capacity and knowledge of the nutritional value of some local foods and their production improve drastically [17]. Among these local

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foods include seasonings; over 500 seasonings are made up from plants; some are cultivated while some are grown wild [1]. Seasoning, such as condiment ogiri Anambra are used to add taste or flavour to food. There are over 2,000 known food seasonings in Africa and most of them are derived from plants and valued for their bulking effects, while others may be used for garnishing or spicing foods [14]. Seasonings are of two types; fermented food seasonings or local seasonings are those food seasonings which undergo traditional food processing method that involves biochemical changes brought about by microbes inherent in grain or derived from a starter culture and their enzymes [1]. Traditional fermented condiments used in Nigeria includes African oil bean (*Pentadethra macrophylla*), ogiri (a fermented melon, soybean, or African yam bean paste), African locust bean (Dawadawa), and Okpeye (*Prosopis africana*) [33].

Castor seed (*Ricinus communis*), the castor bean or castor oil plant, is a species of perennial flowering plant in the spurge family, *Euphorbiacae*. It reproduces with a mixed pollination system which favours selfing by geitonogamy but at the same time can be an out-crosser by anemophily or entomophily [38]. Castor seed is the source of castor oil, which has a wide variety of uses. The seeds contain between 40% and 60% oil, which is rich in triglycerides, particularly ricinolein. The oil is predominantly composed of ricinoleic acid, along with other minor fatty acids such as stearic acid, palmitic acid, and oleic acid [41]. Castor seeds also contain a highly potent water-soluble toxin called ricin, which is found in higher concentrations in the seeds and lower concentrations throughout the plant [5]. Ricin is one of the most dangerous toxins known, and its toxicity can vary depending on the variety and size of the castor seed [25]. In addition to ricin, castor seeds contain other anti-nutritional factors such as the alkaloid ricinine, which contributes to the plant's toxicity [41]. Raw castor seeds are also composed of significant amounts of carbohydrates (61.04%), ash (6.02%), fat (6.65%), fiber (6.62%), and calcium (0.30 mg/100g), making them a potential resource for oil production but also emphasizing the need for careful handling due to their toxic components [26].

Fermented condiments despite the nutrient quality in the form of ogiri is under-utilized due to the advent of bouillon cubes or monosodium glutamate which comes in dehydrated forms, with high level of tastiness and synthesized aromas but with no nutritive and functional benefits to the human body. Consequently, the use of non- fermented condiments during food preparation has also lead to deficiency of amino acids derivable when fermented condiments such as fermented ogiri from seeds of castor, pumpkin, melon, soybean, African locust bean (Dawadawa) and Okpeye (*Prosopis Africana*) used in food preparation. It is imperative therefore, to carryout comparative quality analysis of selected local fermented condiment. This study revealed the amino acid and phytochemical profile of some selected local fermented condiment (Ogiri-Igbo) sold in Anambra State.

2. Materials and Methods

2.1. Material Procurement

The local fermented condiment (Ogiri Anambra) samples were purchased using random sampling method at different markets comprising of Eke Ichi in Ekwusigo L.G.A., Nwafor (Uruagu) in Nnewi North L.G.A., Eke Uli, Otolo Nnewi in Nnewi L.G.A., and Ifedigo, Ojoto in Idemili South L.G.A. The procured ogiri samples were labeled accordingly and packaged aseptically in cellophane in a small cooler containing ice blocks to prevent deterioration.

2.2. Determination of Amino Acid Profile

The Amino Acid profile in the samples was determined using methods as described by [9]. The known sample was dried to constant weight, defatted using chloroform/methanol mixture of ratio 2:1 in soxhlet extraction apparatus [6] and nitrogen content determined, hydrolyzed [28]. The tryptophan in the known sample was hydrolyzed with 4.2 M Sodium hydroxide [35], evaporated in a rotary evaporator and loaded into the Applied Biosystems PTH Amino Acid Analyzer. The amount loaded was 60 microlitre. This was dispended into the cartridge of the analyzer. The period of an analysis lasted for 45 minutes. An integrator attached to the analyzer calculates the peak area proportional to the concentration of each of the amino acids.

2.3. GC-FID Identification and Quantification of Phytochemical Profiles

The methods described by [31] were used for identification and quantification of the phytochemicals present in the samples. The analysis was carried out using standard instrumental technique of Gas chromatography-flame ionization detection (GC-FID, BUCK M910 Gas Chromatograph (GC) (BUCK Scientific, USA)). For the GC-FID analysis, 1 g of the sample was weighed and transferred into a test tube. A volume (15 ml) of ethanol and 10 ml of 50% w/v potassium hydroxide were added to the crushed seed in the test tube. The test tube was allowed to stand in a water bath at 60 ^{o}C for 60 minutes. Then the content of the test tube was carefully transferred into a separating funnel and the tube rinsed into the same funnel with 10 ml of cold water, 10 ml of hot water, 20 ml of ethanol and 3 ml of hexane. The extract from the separating funnel was washed three times with 10 ml of 10% v/v ethanol solution. The extract solution was then dried with anhydrous sodium sulphate and the solvent was evaporated. A sample of the extract was then made soluble in 100 µl of pyridine of which 20 µl was transferred into a vial of the Gas Chromatography machine for phytochemical analysis. The GC-FID antinutrient analysis was performed on a BUCK M910 Gas Chromatograph (GC) (BUCK Scientific, USA), equipped with a flame

ionization detector (FID). A RESTEK 15 meter MXT-1 column (15 m x 250 µm x 0.15 µm) was used. The injector temperature was 280°C with splitless injection of 2 µl of sample and a constant linear velocity of 30 cms^{-1}; while Helium 5.0 Pas was the carrier gas with a flow rate of 40 $mlmin^{-1}$. The oven was operated initially at 200°C, then subsequently heated to 330°C at a rate of 3°C min^{-1} and kept at the temperature of 320°C. Phytochemicals were determined by the ratio between the area and mass of internal standard and the area of the identified phytochemicals.

3. Result and Discussion

3.1. Amino Acid Profile of the Ogiri-igbo from Fermented Castor Seed

Presented in Table 1 below are the amino acid profiles of four different Ogiri-igbo samples from fermented castor oil seed, purchased from Ekeulo, Nwofor Uruagu, Fedigo and Eke-ichi markets in Anambra State. The samples were coded as A1, A2, A3 and A4 respectively. The amino acids determined were leucine, lysine, isoleucine, phenylalanine, Tryptophan, valine, methionine, proline, arginine, tryrosine, histidine, cystine, alanine, glutamic acid, glycine, threonine, serine and aspartic acid. The leucine content of the samples A1, A2, A3 and A4 were 7.25, 6.93, 7.17 and 7.57 g/100g respectively. The result showed that sample purchased from Eke-Ichi market (A4) had the highest (7.57 g/100g) concentration of leucine and was statistically found to be significantly different ($p<0.05$). The leucine values obtained in this study were comparable to the values (5.41 to 7.61 g/100g) obtained [7] for the leucine content of ogiri. The values obtained were also found to be slightly higher than FAO/WHO [19], leucine reference value of 6.6 g/100g. Leucine is an essential amino acid which the body cannot synthesize and, therefore, its presence in the ogiri-igbo samples will contribute to protein synthesis.

The lysine content of the four ogiri-igbo samples were 7.26 g/100g (A1), 5.97 g/100g (A2), 6.74 g/100g (A3) and 6.55 g/100g (A4) respectively. The lysine content of the samples showed significant ($p<0.05$) differences. The ogiri-igbo sample bought from Eke-Uli market (A1) had the highest (7.26 g/100g) lysine content while its counterpart from Nwofor Uruagu market (A1) had the lowest (5.97 g/100g) lysine content. The values obtained in this study were found to be higher than the result obtained [15] on ogiri from Akwuette (4.2 g/100g) and on ogiri egusi (4.51 g/100g) [32]. Lysine is an essential amino acid, thus is involved in protein synthesis. It also helps in hormone and enzyme production and calcium absorption. It is important for energy production, immune function and production of collagen and elastin [48]. The isoleucine content of the samples was 4.40 g/100g (A1), 4.48 g/100g (A2), 4.53 g/100g (A3) and 4.62g/100g (A4). The isoleucine values of the ogiri-igbo samples had significant difference ($p<0.05$). The results showed that isoleucine content of sample A4 was most predominant compared to other samples where A1 had the lowest (4.40 g/100g) isoleucine content. The values in this study were found extremely higher than the value (0.92 g/100g) reported by [2] for fermented fluted pumpkin seed ogiri. It was reported that isoleucine is involved in healing/repair of muscle tissue. It is important for immune function; hemoglobin production and energy regulations [48]. The phenylalanine content of the ogiri-igbo samples were 5.76 g/100g (A1), 5.42 g/100g (A2), 5.59 g/100g (A3) and 5.58 g/100g (A4). The results obtained revealed that the phenylalanine content significantly ($p<0.05$) differed from each other. The sample purchased from Nwofor Uruagu market (A2) had the lowest (5.42 g/100g) phenylalanine content while sample from Eke-Uli market (A1) had the highest (5.76 g/100g) phenylalanine content. Phenylalanine contents in this present study were higher compared to 2.62 g/100g reported by [24] for phenylalanine content of fermented locust bean. Phenylalanine is an essential amino acid. It is beneficial for healthy nervous system. It boosts memory and learning. Phenylalanine is a precursor for neurotransmitters tyrosine, dopamine, epinephrine, and norepinephrine. It plays an integral role in structure and function of proteins and enzymes and production of other amino acids [48]. The tryptophan contents were 1.32 g/100g (A1), 1.35 g/100g (A2), 1.23 g/100g (A3) and 1.28 g/100g (A4). The results obtained showed that the tryptophan content of all the ogiri-igo samples had significant difference ($p<0.05$). The Nwofor Uruagu ogiri-igbo (A2) had the highest (1.35 g/100g) tryptophan content while the Ifedigo market (A3) ogiri-igbo had the lowest (1.23 g/100g) tryptophan content. The values of tryptophan in this study were found lower than 6.0 g/100g reported by [16] for ogiri from Akwuette but slightly higher than FAO/WHO [18] tryptophan reference value of 1.0 g/100g. Tryptophan is an essential amino acid which helps to maintain nitrogen balance. It is a precursor to serotonin, a neurotransmitter that regulates appetite, sleep and mood [48].

Table 1. *Amino Acid Profile of Local Fermented Condiment (Ogiri Anambra).*

Amino acids (g/100g)	Samples				
	A1	A2	A3	A4	LSD
Leucine	$7.25^{b}\pm 0.07$	$6.93^{c}\pm 0.01$	$7.17^{b}\pm 0.01$	$7.50^{a}\pm 0.01$	0.03742

Amino acids (g/100g)	Samples				
	A1	A2	A3	A4	LSD
Lysine	$7.26^{a} \pm 0.01$	$5.97^{a} \pm 0.07$	6.74^{a} 0.28	$6.55^{b} \pm 0.07$	0.03532
Isoleucine	$4.40^{c} \pm 0.02$	$4.48^{c} \pm 0.02$	$4.53^{b} \pm 0.01$	$4.62^{a} \pm 0.07$	0.01658
Phenylalanine	$5.76^{a} \pm 0.07$	$5.42^{c} \pm 0.01$	$5.59^{b} \pm 0.07$	$5.58^{b} \pm 0.07$	0.0036
Tryptophan	$1.32^{a} \pm 0.01$	$1.35^{b} \pm 0.01$	$1.23^{b} \pm 0.02$	$1.28^{c} \pm 0.07$	0.01275
Valine	$5.03^{b} \pm 0.07$	$4.75^{d} \pm 0.01$	$4.93^{d} \pm 0.02$	$5.11^{a} \pm 0.00$	0.01061
Methionine	$1.44^{a} \pm 0.03$	$1.30^{d} \pm 0.00$	$1.38^{b} \pm 0.00$	$1.36^{c} \pm 0.00$	0.01458
Proline	$3.90^{b} \pm 0.01$	$3.86^{c} \pm 0.00$	$4.28^{a} \pm 0.01$	$3.96^{b} \pm 0.00$	0.0100
Arginine	$6.89^{b} \pm 0.01$	$6.55^{d} \pm 0.01$	$7.07^{a} \pm 0.01$	$6.72^{c} \pm 0.01$	0.0118
Tyrosine	$3.97^{b} \pm 0.02$	$3.63^{c} \pm 0.01$	$3.93^{d} \pm 0.02$	$4.31^{a} \pm 0.01$	0.0249
Histidine	$3.53^{a} \pm 0.02$	$3.33^{c} \pm 0.00$	$3.56^{a} \pm 0.21$	$3.42^{c} \pm 0.00$	0.01458
Cystine	$2.07^{b} \pm 0.14$	$1.88^{b} \pm 0.07$	$1.75^{c} \pm 0.01$	$2.02^{b} \pm 0.01$	0.01500
Alanine	$4.57^{b} \pm 0.31$	$4.40^{d} \pm 0.01$	$4.98^{b} \pm 0.01$	$5.24^{a} \pm 0.02$	0.0229
Glutami acid	$15.0^{c} \pm 0.01$	$13.78^{a} \pm 0.01$	$14.34^{b} \pm 0.02$	$14.62^{b} \pm 0.07$	0.01658
Glycine	$4.23^{c} \pm 0.01$	$3.85^{d} \pm 0.01$	$4.27^{b} \pm 0.14$	$4.62^{a} \pm 0.01$	0.03775
Threonine	$3.62^{d} \pm 0.01$	$4.04^{b} \pm 0.02$	$3.78^{c} \pm 0.07$	$3.94^{c} \pm 0.01$	0.01369
Serine	$4.25^{b} \pm 0.01$	$4.04^{b} \pm 0.14$	$4.17^{d} \pm 0.01$	$3.94^{c} \pm 0.02$	0.01871
Aspartic acid	$10.81^{a} \pm 0.01$	$10.53^{b} \pm 0.01$	$9.94^{d} \pm 0.01$	$10.22^{c} \pm 0.02$	0.01871

Mean values having different superscripts along the same row are significantly different ($P \leq 0.05$). Key: Sample A1 = Ogiri from Eke Uli market, Sample A2= Ogiri from Nwofor Uruagu, Sample A3= Ogiri from Ifeadigo market, Sample A4 = Ogiri from Eke-Ichi market.

The valine concentrations were 5.03 g/100g (A1), 4.75 g/100g (A2), 4.93 g/100g (A3) and 5.11g /100g (A4). The results obtained showed that the valine content had significant difference ($p<0.05$). The sample obtained from Eke-Ichi (A4) had the highest (5.11 g/100g) valine concentration while the Nwofor Uruagu sample (A2) had the lowest (4.75 g/100g) valine concentration. The concentration of valine in the samples as obtained in this study were found to be higher than 2.54 g/100g to 4.56 g/100g reported by [49] for different fermented soup condiments. The methionine content was 1.44g/100g (A1), 1.30g/100g (A2), 1.38g/100g (A3) and 1.36g/100g (A4). The sample from Eke-Uli (A1) had the highest (1.44g/100g) methionine content while Nwofor Uruagu sample (A2) had the lowest (1.25g/100g) methionine content. Irrespective of the fact that all this samples were all made from fermented castor oil seed, the results obtained revealed that the methionine content of all the ogiri-igbo samples had significant difference ($p>0.05$). The differentials between the methionine contents of the ogiri-igbo samples could be linked to differences in location of production/purchase, variations in processing methods as well as species/maturity of the castor oil seeds used. Methionine helps remove toxic waste from the liver and assist in regeneration [34].

The proline content was 3.90 g/100g (A1), 3.86 g/100g (A2), 4.28 g/100g (A3) and 3.96 g/100g (A4). The sample from Ifedigo (A3) had the highest (4.28 g/100g) proline content while sample from Nwofor Uruagu (A2) had the lowest (3.86 g/100g) proline content. The results obtained revealed that the proline content of the samples had significant difference ($p<0.05$). The values obtained in this study were relatively close to the value (3.68g/100g) reported by [34] for ogiri produced from fermented locust bean. Proline is a non-essential amino acid. It plays important role in intracellular signaling [39]. The arginine contents of the samples were 6.89 g/100g (A1), 6.55 g/100g (A2), 7.07 g/100g (A3) and 6.72 g/100g (A4). The results revealed that the arginine content of the samples were significantly ($p<0.05$) different. The sample from Ifedigo (A1) had the highest (7.07 g/100g) while sample from Nwofor Uruagu (A2) had the lowest (6.55 g/100g) arginine content. The concentrations of arginine in the samples were found to be higher than 3.00g/100g reported by [34] for ogiri made from fermented locust bean. The Arginine is a non-essential amino acid which can be gotten from food sources. It plays important role in the brain development especially at infancy. It helps in the production of growth hormones [34].

The tyrosine contents for samples A1, A2, A3 and A4 were

3.97 g/100g, 3.63 g/100g, 3.93 g/100g and 4.31 g/100g respectively. The results showed that the tyrosine contents of the samples significantly ($p<0.05$) differed. Sample from Eke-Ichi (A4) had the highest (4.31 g/100g) while sample from Nwofor-Uruagu (A2) had the lowest (3.63 g/100g) tyrosine content. The tyrosine content of the samples had values closely related to 2.14 to 4.13 g/100g reported by [49] for soup condiments made from different legumes. Tyrosine is a non-essential amino acid. Tyrosine is a precursor of dopamine, norepinephrine and adrenaline which helps to enhances positive mood [29]. The histidine contents for samples A1, A2, A3 and A4 were 3.53 g/100g, 3.33 g/100g, 3.56 g/100g and 3.42 g/100g respectively. The results revealed that the histidine contents of the samples had significant difference ($p<0.05$). The sample from Ifedigo (A3) had the highest (3.56g/100g) while sample from Nwofor Uruagu (A2) had the lowest (3.33 g/100g) histidine content. The histidine content had values close to 2.14 to 3.39 g/100g reported by [49] for soup condiments made from different legumes. Histidine is an essential amino acid which helps facilitates growth, creation of blood cells, and tissue repair. It also helps maintain the special protective covering over the nerve cell, which is called the myelin sheath [10]. The cystine content was 3.53 g/100g (A1), 3.33 g/100g (A2), 3.56 g/100g (A3) and 3.42 g/100g (A4). The results revealed that the cystine contents of the samples differed significantly ($p<0.05$). The sample from Ifedigo (A3) had the lowest (1.75 g/100g) while sample from Eke-Uli (A1) had the highest (2.07 g/100g) cystine content. Cystine is a non-essential amino acid and it acts as an antioxidant and has synergistic effect when taken with other antioxidants such as vitamin E and selenium [13].

The alanine concentrations in samples A1, A2, A3 and A4 were 4.57 g/100g, 4.40 g/100g, 4.98 g/100g and 5.24 g/100g respectively. The alanine contents of the samples significantly ($p<0.05$) differed and sample from Eke-Ichi (A1) had the highest (5.24 g/100g) while sample from Nwofor Uruagu (A2) had the lowest (4.40 g/100g) alanine content. The amount of alanine in this study falls within 1.90 to 5.50g/100g reported by [49] for soup condiments made from different legumes. Alanine is a non-essential amino acid and contributes to the removal of toxic substances released from the breakdown of muscle protein during intensive exercise [48]. The glutamic acid content of samples A1, A2, A3 and A4 were 15.0 g/100g, 13.78 g/100g, 14.34 g/100g and 14.62 g/100g respectively. The glutamic acid content of the samples showed significant ($p<0.05$) difference. The sample from Eke-Uli (A1) had the highest (15.0 g/100g) while sample from Nwofor Uruagu (A2) had the lowest (13.6g/100g) glutamic acid content. Amongst all the amino acids present in the samples, glutamic acid is the most predominant and this observation corresponds to the findings of [49]. Glutamic acid is a non-essential amino acid and it plays important role in amino acid metabolism because of its role in transamination reactions and is necessary for the synthesis of key molecules, such as glutathione which is required for the removal of highly toxic peroxides and the polyglutamate folate cofactors [12].

The samples had glycine contents of 4.23 g/100g (A1), 3.85 g/100g (A2), 4.27 g/100g (A3) and 4.62 g/100g (A4). The glycine content of the samples significantly ($p<0.05$) differed. Glycine concentration in the sample from Eke-Ichi (A4) was the highest (4.62 g/100g) while sample from Nwofor Uruagu (A2) had the lowest (3.85 g/100g) glycine content. The values obtained for glycine in this study falls within values (2.99 - 5.16 g/100g) reported by [49] for ogiri made by fermenting different legumes. Glycine is an amino acid that our body uses to create proteins, our bodies naturally produce glycine from other amino acids, which it needs for the growth and maintenance of tissue and for making important substances such as hormones and enzymes [24]. The threonine contents of the samples were presented in 3.62 g/100g (A1), 4.04 g/100g (A2), 3.78 g/100g (A3) and 3.94 g/100g (A4). The results obtained showed that it is significantly ($p<0.05$) different. The sample from Nwofor Uruagu (A1) had the highest (4.04g/100g) while sample from Eke-Uli (A1) had the lowest (3.75g/100g) threonine content. The threonine content closely relates to the FAO/WHO [18] threonine reference value of 3.4 g/100g. Threonine is an essential amino and a major part of collagen and elastin, which are important components of skin and connective tissue. It also plays a role in fat metabolism and immune function [48]. The serine contents in samples A1, A2, A3 and A4 were 4.25 g/100g, 4.04 g/100g, 4.17 g/100g and 3.94 g/100g respectively. The serine content were significantly ($p<0.05$) different. The serine content in sample from Eke-Uli (A1) had the highest (4.25g/100g) while sample from Eke-Ichi (A4) had the lowest (3.94g/100g) serine content. The serine content is close to the serine content (2.40 to 4.59 g/100g) reported by [49] for soup condiments made from different legumes. Serine is a non-essential amino acid which plays many important roles in cell signaling and is used for treatment of schizophrenia [11]. The aspartic acid contents for samples A1, A2, A3 and A4 were 10.81g/100g, 10.53g/100g, 9.94g/100g and 10.22g/100g respectively. The aspartic acid contents of the samples significantly ($p<0.05$) differed. Aspartic acid is the second most predominant amino acids after glutamic acid in the ogiri-igbo and that from Eke-Uli (A1) had the highest (10.81 g/100g) while sample from Ifedigo (A3) had the lowest (9.94g/100g) aspartic acid content. [49], reported aspartic acid content of 7.63 to 9.64 g/100g for different fermented soup condiments.

3.2. Phytochemical Profile of Ogiri-igbo from Fermented Castor Seed

The phytochemical profiles of the local fermented condiment (Ogiri-igbo) from castor seed are shown in Table 2. Catechin was detected in the samples obtained from Eke-Uli (A1), Nwafor (A2), Ifeadigo (A3) and Eke-Ichi (A4) markets with values 35.87, 4.35, 4.35 and 0.00 mg/100g respectively. The

bioactive compound catechin was most predominant in sample A1 (35.87 mg/100g), while samples A2 and A3 had similar catechin content of 4.35 mg/100g with A4 not detected. The concentrations of catechin in samples A1 were found substantially different ($p<0.05$) from those of samples A2 and A3. According to [20] and [22] catechin is a flavanol with potential cardiovascular protective effects such as improvement of vasodilation and endothelial functions as well as maintains blood pressure and insulin resistance and glucose tolerance. This is supported by findings from [23], who reported that flavonoid-rich foods, particularly those containing catechins such as dark chocolate, significantly improve insulin sensitivity and reduce blood pressure in healthy individuals. The bioactive compound daidzein was only present in samples A1, A2, and A3 and the quantity of this bioactive compound present in the aforementioned samples were 1.59, 8.05 and 8.04 mg/100g respectively. The daidzein content of showed significant ($p<0.05$) differences and the concentration of daidzein was highest (8.05 mg/100g) in sample A2 while sample A1 had the lowest (1.59 g/100g). Daidzein is an isoflavonic phytoestrogen belonging to the non-steroidal estrogens and is mainly derived from leguminous plants. It has been widely studied for its therapeutic properties and these health-promoting effects are supported by [43], who reported that daidzein is a key bioactive compound in traditional medicine with significant physiological and pharmacological benefits and further supported by [47], who highlighted its diverse therapeutic applications and health-promoting potential. It is a bioactive ingredient in traditional Chinese medicine Gegen [45] and it is used frequently in the treatment of fever, acute dysentery, diarrhea, diabetes, cardiac dysfunctions, liver injury etc. [46].

The presence of the naringenin was detected in the samples from Eke-Uli (A1), Nwafor (A2), Ifedigo (A3) and Eke-Ichi (A4) showing 8.47, 4.30, 4.30 and 9.80 mg/100g respectively. The concentrations of naringenin in the samples showed significant ($p<0.05$) differences with exceptions to samples A2 and A3 with same values. The concentration of naringenin was highest (9.80 mg/100g) in sample A4 while sample A2 and A3 had the lowest (4.30mg/100g). Naringenin is endowed with broad biological effects on human health, which includes a decrease in lipid peroxidation biomarkers and protein carbonylation, promotes carbohydrate metabolism, increases antioxidant defenses, scavenges reactive oxygen species, modulates immune system activity, and also exerts anti-atherogenic and anti-inflammatory effects [44]. The presences of kaempferol were detected in the samples procured at Eke-Uli (A1), Nwafor (A2) and Ifeadigo (A3) markets. The kaempferol in samples A1, A2 and A3 had values 1.28, 7.56 and 7.56 mg/100g respectively. The highest (7.56 mg/100g) was samples A2 and A3 while sample A1 had the lowest (1.28 mg/100g) kaempferol content. The concentration of kaempferol as detected in the three samples (A1, A2 and A3) were significantly different ($p<0.05$). [3] and [36] both reported that kaempferol has anti-carcinogenic and anti-inflammatory potentials.

Table 2. *Phytochemical Profile of Local Fermented Condiment (Ogiri Anambra).*

Name	A1	A2	A3	A4	LSD
Catechin	$35.87^{a}\pm0.03$	$4.35^{b}\pm0.01$	$4.35^{b}\pm0.01$	-	0.04
Apigenin	$1.84^{a}\pm0.02$	$1.91^{a}\pm0.01$	$1.91^{a}\pm0.05$	1.61 ± 0.01	0.09
Geinistein	$10.36^{a}\pm0.02$	$1.49^{b}\pm0.05$	$1.49^{b}\pm0.01$	-	0.05
Ellagic Acid	$7.99^{a}\pm0.04$	$2.77^{c}\pm0.02$	$2.77^{c}\pm0.01$	$2.92^{b}\pm0.01$	0.05
Daidzein	$1.59^{c}\pm0.03$	$8.05^{a}\pm0.01$	$8.04^{b}\pm0.01$	-	0.04
Coumaric Acid	3.99 ± 0.01	-	-	-	-
Flavone	5.91 ± 0.04	-	-	-	-
Daidzin	5.81 ± 0.03	-	-	-	-
Butein	1.72 ± 0.02	-	-	-	-
Quercetin	$19.48^{a}\pm0.02$	$2.81^{b}\pm0.01$	$2.8^{b}\pm0.02$	-	0.06
Gentisic Acid	5.19 ± 0.03	-	-	-	-
Syringic Acid	1.25 ± 0.02	-	-	-	-
Naringenin	$8.47^{b}\pm0.05$	4.30c±0.00	$4.30^{c}\pm0.02$	$9.80^{a}\pm0.01$	0.06
Luteolin	$4.97^{a}\pm0.02$	$1.24^{c}\pm0.02$	$1.24^{c}\pm0.02$	$1.71^{b}\pm0.01$	0.07
Baicalin	$2.47^{b}\pm0.02$	$3.67^{a}\pm0.04$	$3.67^{a}\pm0.03$	$1.76^{c}\pm0.01$	0.05
Kaempferol	$1.28^{b}\pm0.02$	$7.56^{a}\pm0.03$	$7.56^{a}\pm0.04$	-	0.03

Name	A1	A2	A3	A4	LSD
Epicatechin	$1.32^{c}\pm0.04$	$1.39^{b}\pm0.01$	-	$3.14^{a}\pm0.03$	0.04
Epigallocatechin	-	-	-	-	-
Gallocatechin	-	-	-	-	-
Robinetin	-	-	-	-	-
Myricetin	$90.32^{a}\pm0.04$	$4.28^{c}\pm0.01$	$4.28^{c}\pm0.01$	$5.45^{b}\pm0.04$	0.07
Nobiletin	1.97 ± 0.04	-	-	-	-
Tangeretin	-	$4.16^{b}\pm0.03$	$4.16^{b}\pm0.01$	$4.54^{a}\pm0.02$	0.03
Artemetin	-	$16.29^{a}\pm0.04$	$16.29^{a}\pm0.07$	$1.68^{b}\pm0.02$	0.06
Naringin	-	$1.68^{b}\pm0.03$	$1.68^{a}\pm0.01$	$1.95^{a}\pm0.03$	0.02
Cinnamic Acid	-	-	-	-	-
Vinnillic Acid	2.10 ± 0.03	-	-	-	-
Ferrullic Acid	-	-	-	-	-
Piperic Acid	-	-	-	-	-
Flavon-3-ol	-	-	-	-	-
Cinnamic Acid	-	-	-	-	-
Sinapinic Acid	-	-	-	-	-
Resmarinic	-	-	-	-	-
Retusin	-	$1.12^{b}\pm0.01$	$1.12^{b}\pm0.02$	$5.86^{a}\pm0.02$	0.04
Gallocatechin	-	$2.85^{a}\pm0.03$	$2.85^{a}\pm0.03$	$1.75^{b}\pm0.03$	0.03
Tangeretein	-	$3.98^{b}\pm0.02$	$3.98^{b}\pm0.01$	$5.79^{a}\pm0.02$	0.04
Nobeletin	-	-	-	-	-
Sorhamnetic	-	-	-	-	-
Ferulic acid	-	-	-	-	-
Reveratol	$6.50^{a}\pm0.04$	$2.07^{b}\pm0.01$	$2.07^{b}\pm0.02$	$1.37^{c}\pm0.03$	0.07

Mean values having different superscripts along the same row are significantly different ($P\leq0.05$). Key: Sample A1 = Ogiri from Eke Uli market, Sample A2= Ogiri from Nwofor Uruagu, Sample A3= Ogiri from Ifeadigo market, Sample A4 = Ogiri from Eke-Ichi market.

The presence of luteolin was detected in all the samples from Eke-Uli (A1), Nwafor (A2), Ifedigo (A3) and Eke-Ichi (A4) markets as 4.97, 1.24, 1.24 and 1.71 mg/100g. The highest (4.97 mg/100g) was sample A1 while samples A2 and A3 had the lowest (1.24mg/100g) luteolin content. The concentration of luteolin in samples A2 and A3 did not show any significant difference ($p>0.05$) but differed significantly ($p<0.05$) with other samples. [40], and [37] reported that luteolin has the ability to penetrate into human skin and effectively treat and prevent cancer of the skin. It inhibits the carcinogens metabolism, inhibit new blood vessels growth inside tumors, stopping the progression of cancer cell cycle and also induced the cell death in cancer cells. Epicatechin was only detected in samples A1, A2 and A4 and their values were 1.32, 1.39 and 3.14 mg/100g respectively. Epicatechin contents was found to be significantly ($p<0.05$) different. The concentration of epicatechin was highest (3.14 mg/100g) in sample A4 while sample A1 had the lowest (1.32 mg/100g). Epicatechin has diverse biological properties, out of which the major biological properties that they possess are antioxidant, antimicrobial, anti-inflammatory, antitumor and cardioprotective activity [30]. Just like catechin, epicatechin has potential cardiovascular protective effects including the improvement of vasodilation and endothelial function [21], blood pressure and insulin resistance and glucose tolerance [22].

Quercetin is a bioflavonoid and was only detected in samples A1, A2 and A3. The quercetin content in the samples was 19.48, 2.81 and 2.8 mg/100g respectively. Sample A1 had the highest (19.48 mg/100g) while sample A3 had the lowest (2.8 mg/100g) quercetin content. The concentration of quercetin in samples A1 significantly differed ($p<0.05$) with samples A2

and A3 while samples A2 and A3 showed no significant difference ($p>0.05$). [4], reported quercetin as one of the most widely used bioflavonoids for the treatment of metabolic and inflammatory disorders. It is one of the most abundant dietary flavonoids found in fruits, green leafy vegetables as well as many seeds. Gallocatechin was detected in three samples A2, A3 and A4 as 2.85, 2.85 and 1.75mg/100g respectively. Gallocatechin content of samples A2 and A3 had same values with the highest (2.85 mg/100g) while sample A4 had the lowest (1.75 mg/100g). The gallocatechin content of samples were found to be significantly different ($p<0.05$). Baicalin was detected in samples A1, A2, A3 and A4. Baicalin concentrations in the samples were 2.47, 3.67, 3.67 and 1.76 mg/100g. Samples A2 and A3 had same baicalin content and the highest (3.67 mg/100g) while sample A4 had the lowest (1.76 mg/100g). The concentration of baicalin in the samples were found to be significantly different ($p<0.05$) with exceptions to samples A2 and A3 with same baicalin value.

Myricetin was detected in all samples A1 and A2, A3 and A4 with values 90.32, 4.28, 4.28 and 5.45 mg/100g respectively. Sample A1 had the highest (90.32 mg/100g) while samples A2 and A3 with same values had the lowest (4.28 mg/100g) myricetin content. The concentration of myricetin in sample A2 and A3 was not significantly different ($p>0.05$). According to [27], myricetin has nutraceuticals and anti-oxidant properties which are highly valued and these scientific evidences underscores claims that the myricetin displays a variety of pharmacological activities, including anti-inflammatory, analgesic, anti-tumor, hepatoprotective and antidiabetic activities. Resveratrol was detected in all samples A1, A2, A3 and A4 r as 6.50, 2.07, 2.07 and 1.37 mg/100g respectively. Sample from Nwafor and Ifeadigo (A2 and A3) markets had same values, hence were not significantly different ($p>0.05$), but differed significantly ($p<0.05$) with samples A1 and A4 respectively. Resveratrol is currently used in the treatment of cancer, slow ageing, cardio-vascular disease, antiviral therapies, inflammation, platelet aggregation, and a number of other disorders [50]. Genistein content showed that this bioactive compound was only detected in samples A1, A2 and A3 and were 10.36, 1.49 and 1.49 mg/100g respectively. Genistein content of sample from Eke-Uli (A1) had the highest (10.36 mg/100g) while the sample from Nwafor and Ifedigo markets had the lowest (1.49 mg/100g) genistein content. The concentration of genistein detected in sample A1 was found to be significantly different ($p<0.05$) from samples A2 and A3. The bioactive compound genistein was not detected in sample A4 and could be attributed to differences in processing methods used by the ogiri-igbo processors.

Apigenin content of samples A1, A2, A3 and A4 had 1.84, 1.91, 1.91 and 1.61 mg/100g respectively. The apigenin content of sample from Nwafor and Ifeadigo market (A2 and A3) had the highest (1.91 mg/100g) concentration of apigenin while sample from Eke-Ichi had the lowest (1.61 mg/100g). The concentration of apigenin detected in samples A1, A2 and A3 showed no significant difference ($p<0.05$). The tangeretein content of samples A2, A3 and A4 were 3.98, 3.98 and 5.79 mg/100g respectively. The tangeretein content of sample from Eke-Ichi (A4) had the highest (5.79 mg/100g) concentration while the sample from Nwafor and Ifeadigo (A2 and A3) had the lowest (3.98 mg/100g) tangeretein content. The concentration of tangeretein detected in the samples from Nwafor and Ifeadigo had the same values, hence was not significantly different ($p<0.05$). The ellagic content of samples A1, A2, A3 and A4 had 7.99, 2.77, 2.77 and 2.92 mg/100g respectively. The ellagic content of sample from Eke-Uli (A1) had the highest (7.99 mg/100g) concentration while the sample from Nwafor and Ifedigo had the lowest (2.77 mg/100g). The concentration of ellagic detected in the samples were significantly different ($p<0.05$) with exceptions to samples A2 and A3. The naringin content was 1.68, 1.68 and 1.95 mg/100g for samples A2, A3 and A4 respectively. Samples from Nwafor and Ifeadigo had same value and the lowest (1.68 mg/100g) concentration of naringin while sample purchased from Eke-Ichi (A4) had the highest (1.95 mg/100g) naringin content and was found to be significantly different ($p<0.05$). Naringin is a flavanone which prevents CYP (cytochrome) isoenzymes by inhibiting the production of carcinogens, indicating a potential role in the mitigation of cancer [8]. Aside being an anticancer agent, it has variety of biological qualities, such as antioxidant, anti-inflammatory and cardioprotective properties [3]. Retusin was found present in three out of the four samples and were 1.12, 1.12 and 5.86 mg/100g for samples A2, A3 and A4 respectively. Samples from Nwafor and Ifeadigo had same value and the lowest (1.12 mg/100g) concentration of retusin while sample from Eke-Ichi (A4) had the highest (5.86 mg/100g). The concentration of retusin was found to be significantly different ($p<0.05$). Retusin plays a significant role in biochemical reactions due to its ability to interact with various biomolecules and these interactions contribute to its antioxidant activity and ability to protect cells from oxidative stress [42]. There are other bioactive phytochemicals compounds that were detected only in sample procured only from Eke-Uli. These phytochemicals are coumaric, flavone, butein, gentistic acid, syringic acid and vinillic acid and these phytochemicals were 3.99, 5.91, 1.72, 5.19, and 1.25 mg/100g respectively.

4. Conclusion

The study on quality evaluation of fermented condiment (ogiri-igbo) sold in Anambra State, showed that the sample from Eke-Uli contained most of the amino-acids comprising lysine, phenylalanine, tryptophan, methionine, histidine, cystine, glutamic acid and aspartic acid. The phytochemicals that were present in the samples confirmed that ogiri-igbo could be rich in medicinal bioactive compounds that are needed by human body cells, for proper functioning of the body and capable of inhibiting cancer cell growth, inducing apoptosis (death of cancerous cells), lower blood pressure and improve lipid profiles. The neuro-protective effects of these bioactive

compounds reduce risk of neurodegenerative diseases (Alzheimer's and Parkinson's diseases). The anticipated anti-diabetic effects could die in its ability to regulate blood sugar level.

The amino acid profile showed that the Ogiri-Igbo (fermented castor oilseeds) is rich in amino-acids like lysine, phenylalanine, tryptophan, methionine, histidine, cystine, glutamic acid and aspartic acid, hence consumption of ogiri-igbo and its use as a food supplement is recommended.

Abbreviations

PTH	Phenylthiohydantoin
L.G.A	Local Government Area

Conflicts of Interest

The authors declare no conflicts of interest.

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