

Comparative Evaluation of the Curry Spices as a Source of Nutrient Additives

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ABSTRACT

Curry (*Murraya koenigii*) has been used for flavouring and spicing of food since ancient time and consumption of curry is very high throughout the country especially in Taraba state and by all the tribes. Its medicinal value has also been identified. This work investigated the phytochemical screening, proximate composition, vitamin and mineral composition of the curry leaves and curry flour using standard procedures. The result of the phytochemical analysis revealed the presence of the bioactive constituents comprising flavonoid (2.67±0.01 and 3.15±0.08 mg/100g), steroids (0.35±0.01 to 0.52±0.04 mg/100g) and phenolic (0.83±0.01 to 1.01±0.02 mg/100g), but decrease in saponin (2.96±0.01 to 1.98±0.12mg/100g) in the curry flour and curry leaf respectively the result showed little difference in values between the curry flour and curry leaf. The anti - nutrient composition was found to be as follows; Tannin 0.86±0.01 mg/100g and 1.28±0.03 mg/100g, HCN content 2.72±0.06 and 3.03±0.02 mg/100g, phytate 1.63±0.03 mg/100g and 1.34±0.02 mg/100g, alkaloid content 1.23±0.04 mg/100g and 1.49±0.07 mg/100g. The analysis of the vitamin content showed the presence of the vitamins values for the curry leaves and curry flour were vitamins A (2.65±.01 and 3.56±.06), vitamin C (3.78 ±.13 and 5.50±.06) and vitamin B12(0.17±.01 and 0.31±.05). The starchyose and raffinose values of the curry leaves and curry flour were 0.51±0 .01 - 0.66±0 .04 and 0.36±.03-0.41 ± 0.01%, respectively. The calcium, magnesium, phosphorous, zinc and iron content of the curry leaves and curry flour are 18.62±.08 and 20.29±.19, 28.94±0.09 and 30.95±.08, 35.29 ±0.08 and 42.34±.2, 0.72±.03 and 1.08 ± 0.06, 0.84±.08 and 1.39±0.05 mg/100g, respectively for curry leaves and curry flour. Curry products (leaf and flour) contain some substantial amount of important phytochemicals which possess antioxidant properties and some nutritive vitamins and minerals thus supporting its use as medicinal plant and as food flavouring and spicing condiment.

Keywords: Consumed, Curry Flour (Powder), Curry Leaf, Mineral, Phyto-Nutrients, Vitamin Contents

Introduction

The curry tree (*Murraya koenigii*) is a tropical to sub-tropical tree in the family Rutaceae, which is native to Africa, India, Sri Lanka and other part of the world. The leaves are used in many dishes in Africa, India and other countries. Most traditional cooking in Africa countries basically contains a handful of herbs which help to enhance the flavor of the dish. Curry leaves is the common ingredients in African cooking added in the end to garnish the dishes. Often used in curries, the leaves are generally called by the name “curry leaves”, though they are also translated in different local names. The leaves of *Murraya koenigii* are also used as an herb in Ayurvedic medicine. They are believed to also have an adjuvant action on non-insulin dependent diabetics (people with type- 2 diabetes). Curry leaves have a great impact as anti-carcinogenic action [1].

Curry leaves have properties that can help in lowering one’s blood cholesterol levels [2]. Curry leaves is a staple in African dishes, commonly used as seasoning, this leaf adds a special flavour to every dish it is added to. But there is more to the humble curry leaf than simply flavour. Packed with carbohydrates, fiber,

calcium, phosphorous, iron, magnesium, copper, minerals and vitamins like nicotinic acid and vitamin C, vitamin A, vitamin B, vitamin E, antioxidants, plant sterols, amino acids, glycosides and flavonoids, curry leaves help your heart function better, fights infections and can enliven your hair and skin with vitality. Thus, the present work is to evaluate Photochemical, nutritional and mineral composition curry powder/flour package sold in various markets in Taraba State of Nigeria.

Materials and Methods

Material and Material Preparation

Curry leaves and curry flour (*murraya koenigii*) were obtained from various market in Taraba state, Nigeria. The leaves were dried in the sun and manually, milled (attrition mill) and passed through a sieve of 0.35mm aperture to produce the curry flour and store in room temperature for the analysis.

Determination of Bioactive and Ant-Nutritional Composition of Curry Flour. Determination of Alkaloid

Determination of alkaloid was made by the method described by Oluwole et al. [3]. The alkaloid content was determined gravimetrically. Five grams of the sample was weighed and dispersed in 10% acetic acid solution in ethanol to form a ratio of 1:10 (10%). The mixture was allowed to stand for 4 h at 28°C. It

was later filtered via Whatman No. 42 grade of filter paper. The filtrate was concentrated to one quarter of its original volume by evaporation and treated with drop wise addition of concentrated aqueous NH_4OH until the alkaloid was precipitated. The alkaloid precipitated was received in a weighed filter paper, washed with 1% ammonia solution, and dried in the oven at 80°C . Alkaloid content was calculated and expressed as a percentage of the weight of sample analyzed.

Determination of Saponins

The spectrophotometric method was used for saponin analysis as described by Oluwole et al. [3]. One gram of the flour sample was weighed into a 250-mL beaker and 100 mL isobutyl alcohol was added. The mixture was shaken on a UDY shaker (UDY Corporation, Fort Collins, CO) for 5 h to ensure uniform mixing. The mixture was filtered through a Whatman No. 1 filter paper into a 100-mL beaker and 20 mL of 40% saturated solution of magnesium carbonate was added. The mixture obtained was further filtered through a Whatman No. 1 filter paper to obtain a clear colourless solution. One milliliter of the colourless solution was homogenized into a 50-mL volumetric flask and 2 mL of 5% FeCl_3 solution was added and made up to mark with distilled water and allowed to stand for 30 min for blood red colour to develop. Standard saponin solutions (0-10 ppm) were prepared from saponin stock solution and treated with 2 mL of 5% FeCl_3 solution as done for experimental samples. The absorbance of the sample as well as standard saponin solutions were read after color development on a Spectronic 21D spectrophotometer (Milton Roy, Houston, TX) at a wavelength of 380 nm. The percentage saponin was also calculated.

Determination of Tannin Content: Tannin content of the flour samples was determined using the methods described by Swain [3,4]. The sample (0.2 g) was measured into a 50-mL beaker; 20 mL of 50% methanol was added, covered with homogenizer, placed in a water bath at $77-80^\circ\text{C}$ for 1 h, and the contents stirred with a glass rod to prevent lumping. The mixture was filtered using a double-layered Whatman No. 1 filter paper into a 100-mL volumetric flask using 50% methanol to rinse. This was made up to mark with distilled water and thoroughly mixed. One milliliter of the sample extract was homogenized into a 50-mL volumetric flask, and 20 mL distilled water, 2.5 mL Folin-Denis reagent, and 10 mL of 17% Na_2CO_3 were added and mixed. The mixture was made up to mark with distilled water, thoroughly mixed, and allowed to stand for 20 min when bluish-green coloration developed. Standard tannic acid solutions in the range of 0-10 ppm were treated similarly as the 1 mL sample above. The absorbance of the tannic acid standard solutions as well as samples was read after color development on a Spectronic 21D spectrophotometer at a wavelength of 760 nm. Percentage tannin was calculated.

Determination of phytic acid: An indirect colorimetric method of Wheeler and Ferrel and modified by Oluwole et al. was used for phytate determination [3]. This method depends on an iron to phosphorus ratio of 4:6. A quantity of 5 g of the test sample was extracted with 3% trichloro acetic acid. The phytate was precipitated as ferric phytate and converted to ferric hydroxide and soluble sodium phytate by adding sodium hydroxide. The precipitate was dissolved in hot 3.2 N HNO_3 and the color read immediately at 480 nm. The standard solution was prepared from

$\text{Fe}(\text{NO}_3)_3$ and the iron content was extrapolated from a $\text{Fe}(\text{NO}_3)_3$ standard curve. The phytate concentration was calculated from the iron results assuming a 4:6 iron:phosphorus molecular ratio.

Determination of oxalate content: Oxalate was determined by AOAC method [5]. One gram of the sample was weighed in a 100-mL conical flask. Seventy-five milliliters of 3 mol/L H_2SO_4 was added and the solution was stirred intermittently with a magnetic stirrer for about 1 h and then filtered using Whatman No. 1 filter paper. The sample filtrate (extract) (25 mL) was collected and titrated against hot ($80-90^\circ\text{C}$) 0.1 N KMnO_4 solution to the point when a faint pink color appeared that persisted for at least 30 sec. The concentration of oxalate in each sample was obtained from the calculation: 1 mL 0.1 permanganate = 0.006303 g oxalate

Determination of steroids: The Steroids was determined by the method described by Okeke and Elekwa [6].

Total Carotenoids Determination: According to Yuan et al. 5 g of each defatted moringa EPC were extracted with a mixture of acetone and petroleum ether (1:1, v/v) repeatedly using the mortar and pestle until a colourless residue was obtained [7]. The upper phase was collected and combined with crude extracts after washed for several times with water. The extracts were made up to a known volume with petroleum ether. Total carotenoids content was determined by recording the absorbance at 451 nm with a spectrophotometer. Total carotenoids were calculated and expressed as mg g⁻¹ dw.

Flavonoids Determination: The total flavonoids content of moringa EPC were determined according to the method of Mohdaly et al. [8]. A 0.5 ml aliquot of 2% AlCl_3 ethanolic solution was added to 0.5 ml of the extracts and mixed well. After keeping for 1 h at room temperature, the absorbance at 420 nm was measured. A yellow colour indicates the presence of flavonoids. The total flavonoids content were expressed as mg quercetin equivalent (QE) per 100 g dw.

Determination of total phenolic compounds: The Folin-Ciocalteu assay, adapted from Ramful et al. was used for the determination of total phenolics present in the citrus fruit extracts [9]. To 0.25 mL of diluted extract, 3.5 mL of distilled water was added followed by 0.25 mL of Folin-Ciocalteu reagent (Merck). A blank was prepared using 0.25 mL of 80% methanol instead of plant extract. After 3 min, 1 mL of 20% sodium carbonate was added. Tube contents were vortexed before being incubated for 40 min in a water-bath set at 40°C . The absorbance of the blue coloration formed was read at 685 nm against the blank standard. Total phenolics were calculated with respect to gallic acid standard curve (concentration range: 0-12 μg mL⁻¹). Results are expressed in mg of gallic acid 100 gG1 of plant material.

Determination of starchyosee and raffinose: The high-performance liquid chromatography (HPLC) method for Sugar analysis was used for the determination of raffinose and starchyose [10].

Mineral Determination

AOAC methods were used to determine the mineral compositions of the samples. One gram of sample was digested

with nitric/perchloric/sulfuric acid mixture in the ratio 9:2:1, respectively, and filtered [5]. The filtrate was made up to mark in a 5-mL volumetric flask. The filtered solution was loaded to an Atomic Absorption Spectrophotometer (model 703; Perkin Elmes, Norwalk, CT). The standard curve for each mineral, that is, calcium, magnesium, iron, aluminum, lead, copper, and zinc, was prepared from known standards and the mineral value of samples estimated against that of the standard curve. Values of sodium and potassium were determined using a Flame photometer (Sherwood Flame Photometer 410; Sherwood Scientific Ltd., Cambridge, U.K.) using NaCl and KCl as the standard while phosphorus was determined using the Vanadomolybdate method [5].

Determination of Starch / Protein Digestibility of the Flour

The in vitro protein digestibility of the samples were determined using the procedure described by Mertz et al. and Aboubacar et al. while in vitro starch digestibility were determined as described by Shekib et al. and Chinma et al. [11-14].

Determination of Oligosaccharides (Raffinose and Stachyose)

Raffinose and stachyose were determined by the methods of Matella et al. and Siddiq et al. [15-16].

Quantitative Analysis of the Vitamins

To measure the Vitamin C contents of the samples Gholamreza et al. method was used. The experimental methods described by Gholamreza et al. were used to measure the Vitamin A contents of the sample [17].

Determination of Hydrogen Cyanide

Titrimetric method was used. The titration procedure using silver nitrate with p-dimethylamino-benzal-rhodanine indicator was used [5].

Statistical Analysis

Data was analyzed using analysis of variance. Duncan multiple range test was used to determine significant difference among the various samples in triplicate. Data were analyzed using the software, statistical package for social science (SPSS) version 11.00 SPSS inc., Chicago, IL, USA at the 0.05 level.

Results and Discussion

Phytochemical Composition of Acha-Moringa Flour Blend

The results of the phyto - chemical composition of curry leaves and curry flour sold and consumed in the study areas are shown in Table 1 and Table 2. The two different samples of curry (*murraya koenigii*) have similar values in the two samples analyzed. However the result showed little difference in the curry flour for example, increase in flavonoid (2.67±0.01 and 3.15±0.08 mg/100g), steroids (0.35±0.01 to 0.52±0.04mg/100g) and phenolic (0.83±0.01 to 1.01±0.02mg/100g), but decrease in saponin (2.96±0.01 to 1.98±0.12mg/100g) in the curry flour and curry leaf respectively. The different were significant, $p < 0.05$. The increase in the value of the phytochemical of curry flour could be due to the other additive added to curry flour during processing method of the flour [18,19]. Curry has been found to be a good source of polyphenols and antioxidants [19]. Phytochemicals such as vanillin, omega fatty acids, carotenoids, ascorbates, tocopherols, beta-sitosterol, kaempferol, and quercetin have been reported in some vegetable flowers, roots,

fruits, and seeds [20,21]. The difference in the phenolic values of curry flour and curry leaves could be due to the additive to curry flour (10.179 ± 2.894mg/100g) as earlier reported [22-24]. However, the relatively low value observed in the work could be due environmental factors such as light, germination, degree of ripeness, variety, processing and storage, genetic factors can influence levels. The trace quantities of phenolic compounds indicate that the sample could act as immune enhancers, hormone modulators, antioxidant, anti-clothing and anti-inflammatory Okwu and Omodamoro [25]. They have been reported to be a potential contender to combat free radicals, which are harmful to our body and food systems.

Table 1: Phyto - Chemical Composition of Curry Leaves

Parameters	Curry Flour	Curry Leaves
Saponin (%)	2.96±0.01	1.98±0.12
Flavonid (mg/100g)	2.67±0.03	3.15±0.08
Steroid (mg/100g)	0.35±0.01	0.52±0.04
Phenol(mg/100g)	0.83±0.01	0.83±0.01

Table 2: Anti - Nutrient Composition of Curry Leaves(mg/100g)

Parameters	Curry Flour	Curry Leaves
Tannin	0.86±0.01	1.28±0.03
HCN	2.72±0.06	3.03±0.02
Phytate	1.63±0.03	1.34±0.02
Alkaloid	1.23±0.04	1.49±0.07

The saponin values 1.98-2.94 mg/100 g and 1.78-2.64 mg/100 g observed in the work is relatively higher than the value (0.5mg/100g) observed by Price et al. however, the decrease in the saponin values curry flour could be due to temperature variation during processing method. Saponins are generally characterized by their bitter taste, their ability to foam in aqueous solution, causing nausea, vomiting and their ability to hemolyse red blood cells [26,27]. Similarly, the saponin content of curry flour blends (1.98-2.94mg/100g) were lower than that (5.20 mg/100 g) observed by Seena [28]. The lowering of the saponin value with processing method could be an advantage over the deleterious effects of the same.

The values of flavonoids of the curry leaves and curry flour blend increased from 2.73-3.15mg/100g with processingcurry flour (5-25%), and the increase was significant, $p < 0.5$. The increase could be due to the relatively high level of flavonoid (2.900 ± 0.002mg) inherent in curry flour due to other additive as observed by Sulaiman and Fazilah [22]. Flvonoids have been observed as antioxidant suppress ROS formation either by inhibition of enzymes or by chelating trace elements involved in free radical generation, scavenging ROS; and protection of antioxidant defenses, anti-inflammatory, and antihypertensive properties [23,29-31].

Plant sterols, also called phytosterols, found in plants, are clinically shown to lower LDL cholesterol as part of a heart-healthy diet. Clinical studies suggest that plant sterols can reduce cholesterol by 8-15% [21]. Plant sterols have been observed to be Generally Recognized as Safe in a variety of food and beverage applications [21,32].

Antinutrient Composition of Curry Leaves and Curry Flour Blend

The result of the antinutrient compounds of curry leaves and curry flour are shown in Table 3. The results of curry leaves and curry flour blends showed increase in tannin ranging from (0.86 to 1.28 mg/100g), cyanogenic glycoside (HCN) (2.72 to 3.03 mg/100g), alkaloid (1.23 to 1.49 mg/100g), alkaloid (1.23-1.43mg/100g), but decrease in phytate (1.63- 1.06mg/100g) with the processing method. The increase in the tannin value of the blends agreed with findings of Sulaiman and Fazilah that moringa seed contain 0.890 ± 0.020 mg/100g of tannin [15]. Satinder et al. reported lower value of tannin for wheat bran, rice bran, oat bran and the value reported by Okwu and Ndu is lower than the value reported for this work [33,34]. Tannin contents of the curry leaves and flour (0.98- 1.28mg/100g) were lower than those reported for groundnut seeds (450.00 mg/100 g; Fasoyiro et al.) sorghum grains (280.00 mg/100 g; Elemo et al.) and Cajanus cajan (550.00 mg/100 g; Ayodele and Kigbu) [35,36].

Table 3: Mineral Composition of Curry leaves(mg/100g)

Parameters	Curry Flour	Curry Leaves
Ca	20.29±1.90	14.61±0.29
Mg	30.95±0.08	28.67±0.16
P	42.34±0.20	30.61±0.58
Zn	1.08±0.06	0.66±0.04
Fe	1.39±0.05	0.76±0.01

Tannins have been reported to speed up the rate of healing in enlarged mucous membrane, to be quick in curing of wounds and to possess astringent properties. The presence of tannin in the curry products will support their use in treating haemorrhoid, varicose ulcers, frostbite, burns in herbal medicine and wound Okwu and Okwu [25].

Phytic acid has a strong ability to chelate multivalent metal ions, specially zinc, calcium, iron and as with protein residue. The binding can result in very insoluble salts with poor **bioavailability** of minerals [36]. They reduce the bioavailability and digestibility of nutrients by forming complexes with minerals, protein, digestive enzymes and amino acids mainly lysine, methionine, arginine and histidine.

The hydrogen cyanide value of the Curry leaves and curry flour were very low (2.9 -3.03mg/100g) and insignificant to the upper safe level (50-200 mg/100g or 100-200 ppm) [37]. It could therefore be said that the curry products are safe for consumption and free from ill effects of hydrogen cyanides such as non-specific symptoms, muscular and neurological effects, tachypnea and tachycardia, include seizures, a rapid loss of consciousness, cardiorespiratory depression and collapse, pulmonary oedema and death [38].

The increase in the phytochemical values as observed in this work agreed with observation of Soetan that addition or processing method of curry flour influenced the phytochemical compositions of the flour and subsequently that of the processed food materials [39]. Comparatively, the alkaloid content of curry leaves and curry flour (1.29-1.49mg/100g) were lower than that of the upper limit of 60 mg/100 g recommended for a safe feed [40].

It is evident that antinutrients and phytochemicals have both adverse and beneficial effects in humans [41]. For example, phytic acid, lectins, phenolic compounds and tannins, saponins, enzyme inhibitors, cyanogenic glycosides, and glucosinolates reduce the bioavailability of certain nutrients and impair growth in children [35]. On the contrary, when phytic acid, lectins, and phenolic compounds and saponins were used at low levels, they exhibited hypoglycemic, hypocholesterolemic and anti cancer properties [42,43].

In Vitro Protein and In Vitro Carbohydrate Digestibility of Acha- Moringa Flour Blend

The result of the in-vitro protein and in-vitro starch digestibility of curry leaves and curry flour are shown in Figure 1. The in-vitro protein digestibility increased from 75.70 ± 0.14 - $82.90 \pm 0.18\%$ while the in-vitro starch digestibility decreases from 68.60 ± 0.14 - $62.03 \pm 0.04\%$ for curry leaves and curry flour. The invitro-starch digestibility values obtained in this study is relatively higher than than 26.43-57.25% for tigernut-pigeon pea blend reported by Chinma et al. 32.68-53.12% for unripen plantain-defatted sesame flour blend biscuits and 36.08-52.36% reported by Jishaand for whey-protein concentrate-cassava flour biscuits) [14,44-46]. The decrease in the in-vitro starch digestibility of the curry flour curry leaves may be attributed to the increased crude fiber content which could caused a reduction in the starch digestibility by trapping starch granules within a viscous protein-fiber-starch network [14,44]. The presence of protein bodies around starch granules (due tin increased protein content) as observed by Chinma et al. may restrict granule swelling and starch gelatinization and hence, reduce the susceptibility to enzymatic attack thereby reducing invitro- starch digestibility of curry flour [44].

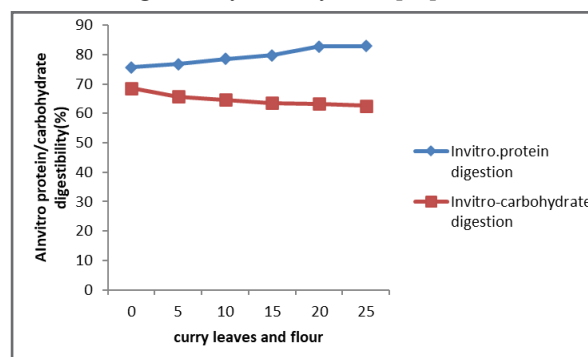


Figure 1: In vitro Protein and carbohydrate digestibility of curry leaves and curry flour

The poor starch digestibility values of the flour as observed by Chinma et al. and Kin-Kabari and Giami may be an indication that the curry flour could serve as a functional food for groups with special calorie and glycemic requirements such as obesity or diabetic people. One of the major developments in the understanding of the importance of carbohydrates for health in the past twenty years has been the discovery of resistant starch. Resistant starch is defined as “starch and starch degradation products not absorbed in the small intestine of healthy humans” [20,44,47]. The main forms of resistant starch are physically enclosed starch, e.g. within intact cell structures (RS₁), some raw starch granules (RS₂) and retrograded amylose (RS₃).

The in-vitro starch digestibility and glycemic property of acha, iburu and maize porridge has been investigated and showing that the total starch (TS) of their respective flours to be 45.3, 43.6

and 41.5% respectively [48,49]. The resistant starch (RS) was 2.9, 2.1 and 1.2 respectively for maize, acha and iburu flours and the digestible starches (DS) 43.7, 41.4 and 40.0%. The authors conclude that acha and iburu may have potential in a low GI food as porridge from both grains had low estimated value of 40 [48]. A relatively higher values of starch digestibility's ($68.60 \pm 0.14\%$) values for 100% was observed in this work.

In vitro-protein digestibility is an important criterion for evaluation of protein quality as well as an indicator for protein bioavailability in foods [44,50]. The in vitro-protein digestibility of the curry leaves and curry flour increased from 75.70 ± 0.14 to $82.90 \pm 0.18\%$ with processing method. The effect of the processing method on the in vitro-protein digestibility of the curry flour is significant, $p < 0.05$. The increase in the in vitro-protein digestibility of the curry flour could be due to the increase in the protein content inherent in the curry flour.

The processing of the curry leaves to the flour improve the protein digestibility over the curry leaves which confirm that flour have better nutritional value than the raw 100% curry leaves. The in vitro-protein digestibility obtained in this work (75.70 ± 0.14 - $82.90 \pm 0.18\%$) is in close agreement with the value (71.20 to 80.0%) reported by El-Adawy (1997) and the value (72.05 to 80.12%) reported by Chinma et al. for wheat-sesame flour blend and for unripe-plantain- sesame flour blend, but slightly higher than the value (60.20 to 71.57%) reported by Chinma et al. for tigernut-pigeon pea flour blend [14,44].

Starchyose and Raffinose Composition of Curry Leaves and Flour

The starchyose and raffinose values of the curry leaves and curry flour ranges from $0.51 \pm .01$ - $0.66 \pm .04$ and $0.36 \pm .03$ - $0.41 \pm .01\%$, respectively, as shown in figure 2. The values of the starchyose and raffinose in the flours and the leaves (100% curry leaves) were relatively low. The presences of starchyose and raffinose could be advantageous or disadvantageous depending on the concentration [16]. Raffinose and starchyose are non-digestible short-chain carbohydrates or oligosaccharides. Humans do not have enzymes to digest them, so they pass unchanged to the colon where the normal intestinal bacteria ferment them to gases (methane, carbon dioxide, hydrogen -gases that are responsible for the characteristic features of flatulence, namely nausea, cramps, diarrhea, and the social discomfort associated with the release of rectal gases.), which can cause abdominal bloating [16,43]. In the large intestine, raffinose and starchyose could act as a soluble dietary fiber, which means they can make stools softer [15,51]. They could also be used as bulk sweeteners [16].

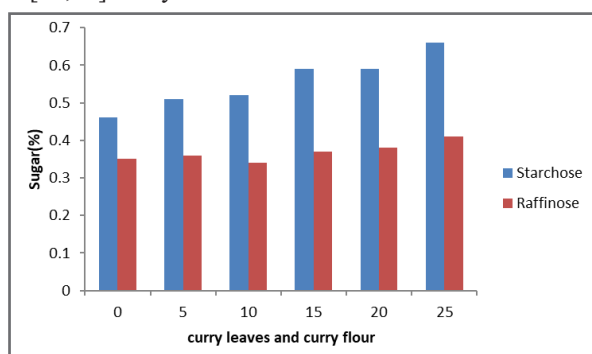


Figure 2: Starchyose and raffinose content of curry leaves and curry flour.

Minerals and Vitamin Composition of Curry Leaves and Curry Flour

The minerals content as macro-elements (calcium, phosphorus and magnesium) and micro elements (iron and zinc) in mg 100 g^{-1} of curry leaves and curry flour are presented in. The calcium, magnesium, phosphorous, zinc and iron content of the curry leaves and curry flour are 18.62 ± 0.08 and 20.29 ± 0.19 , 28.94 ± 0.09 and 30.95 ± 0.08 , 35.29 ± 0.08 and 42.34 ± 0.2 , 0.72 ± 0.03 and 1.08 ± 0.06 , 0.84 ± 0.08 and $1.39 \pm 0.05 \text{ mg}/100\text{g}$, respectively for curry leaves and curry flour. The differences were significantly higher ($p < 0.05$) than the raw curry leaves. The increase in the elemental content processed curry flour agreed with findings of Barakat and Ghazal that the moringa seed flour contain calcium (2016 to 2620mg/100g), magnesium (322 to 340.60 mg/100g), and phosphorous (1817 to 1845mg/100g), while Zn was 1.0mg/100g(w/wt) [18].

The minerals found in *Murraya koenigii* could play both a curative and preventive role in combating human disease. For example, Ca is a multifunctional nutrient essential to the body metabolism and a natural cure for osteoporosis [52-54]. Furthermore, there is strong biological plausibility for the direct impact of Mg intake on cardiovascular disease prevention, insulin sensitivity, and diabetes increasing the rate of pregnant female milk production and healing of wounds and functions as an antioxidant as a result of the high zinc content, Fe has several essential functions in the body, such as its roles in oxygen transport and oxidative metabolism [55-57].

The phosphorous ratio (Ca/P) ratios is an indices for bone formation and the values (0.479-0.527) were relative low and within the recommended (< 1) for diets, particularly for hypertensive patients. Therefore, the observed values for the curry leaves and curry flour in this study is suitable for people who have the risk of high blood pressure and could also be of nutritional benefit, particularly for children and the aged who need higher intakes of calcium and phosphorus for bone formation and maintenance. It is well known that diets with high value of Ca/P ratio are considered "good," particularly for growing children who require high intake of calcium and phosphorus for bone and teeth formation [58]. Zinc is also important in the healing of wounds and functions as an antioxidant.

The results of the vitamin content of the curry flour and 100% curry leaves are shown in. The vitamins values for the curry leaves and curry flour were vitamins A (2.65 ± 0.01 and 3.56 ± 0.06), vitamin C (3.78 ± 0.13 and 5.50 ± 0.06) and vitamin B12 (0.17 ± 0.01 and 0.31 ± 0.05). The vitamins values of the curry flour were significantly ($p < 0.05$) higher than that of the curry leaves (2.51, 3.61 and 0.14 for vit. A, vit. C and vit. C, respectively). The increase could be due to the other additive added during processing method.

Conclusion

The analysis of curry leaves and curry flour sold and consumed in Taraba state was carried out. The research has shown that *Murraya Koenigii* (curry) leaf and curry flour used as spice and flavouring agent in food contains substantial amount of phytochemicals and phytonutrients. The proximate analysis showed that curry leaf and curry flour contains all the parameters determine in the good quantities. The presence of the vitamins

and mineral elements in these curry products showed that it could be consumed to supplement these scarce nutrients. With its content of these anti-oxidants flavonoids, phenols, vitamins E and C, curry products possess anti-cancer and cardio-protective agents supporting its use as medicinal plant and curry flour have a higher of determined parameters than curry leaf.

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