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Full Length Research Article

FORMULATION AND EVALUATION OF MAIZE (*ZEA MAYS*) FLOUR FORTIFIED WITH CARROT (*DAUCUS CAROTA*) POWDER

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ABSTRACT
Macro and micronutrients deficiencies still remain a major challenge with developing countries, especially Sub-Saharan Africa (Nigeria) where maize consumption remains a staple food. These studies investigated the effects of fortification of different blend proportions (BP) of Maize (*Zea Mays*) flower with Carrot (*Daucus Carota*) powder. Standard analytical methods were used to evaluate the proximate, phytochemical, minerals and Vitamins contents in the newly fortified maize flower. The proximate results revealed a significant difference ($p<0.05$) in the moisture, crude fibre and carbohydrates compositions of the blend proportion one (BP1), when compared to blend proportions two and three (BP2 & BP3), while there was a significant increase ($p<0.05$) in the Ash and crude protein contents of blend proportions two and three (BP2 & BP3), when compared to BP1 respectively. The phytochemical results indicates significant increase ($p<0.05$) in Alkaloids, Flavonoids and Saponins in BP1 when compared to BP2 & BP3, while BP2 & BP3 shows a significant increase ($p<0.05$) in Phytates, Oxalates and Tannins compared to BP1.The iron, zinc, sodium, Potassium and Calcium, Vitamin A and Vitamin C compositions revealed a significant increase ($p<0.05$) in BP2 & BP3 compared to BP1. The results revealed that fortification of *Zea Mays* flower with carrot powder increases both macro and micronutrients and it's a cheap methods of meeting the macro and micronutrients needs of a large population, especially in developing countries, as such its consumption should be encouraged.

Keywords: Formulation, Evaluation, Fortification, Maize, Carrot.

INTRODUCTION

Micronutrients are substances in foods that are essential for human health and are required in small amounts. They include all of the known vitamins and essential trace minerals. Micronutrient malnutrition develops when intakes of bioavailable micronutrients are too low to meet requirements. It affects 1/3 of the world population. The 3 most prevalent forms of micronutrient malnutrition are iron, iodine, and vitamin A deficiencies (Akubor, 2005).Fortification is a process of adding micronutrient into food. Fortification of industrially processed flour, when appropriately implemented, is an efficient, simple and inexpensive strategy for supplying vitamins and minerals to the diets of large segments of the population. Maize, also referred to as corn is cultivated in most parts of the world, as it grows in diverse climates. Industrial fortification of maize flour and corn meal with at least iron has been practiced for many years in several countries in the Americas and Africa, where these ingredients are used in the preparation of many common national dishes (Akubor, 2004). A recent study showed that bio fortifying maize flour with higher b-carotene levels is an effective way to improve the vitamin A status of target populations in Uganda (Brennan, 2006).Carrots (Daucus carota) are a root vegetable, usually orange in color, though purple, black, and yellow cultivars exist. Carrots are rich source of β-carotene, which is the most active form of carotenoids, which acts as pro-vitamin A (Stiver, 1955). Carrots can be processed in a wide variety of products. Among these, carrot juice and flour is the most popular (Stiver, 1955). The dried carrot is generally used in instant powdered soups, sauces, seasonings and other kinds of ready-to-eat meals (Ranum, *et al*, 2014). Maize (Zea mays) also referred to as corn is cultivated in most parts of the world, as it is able to grow in diverse climates. Maize is a cereal grain first domesticated by indigenous people of southern Mexico. In 2012, the total world production of maize was over 875 million tones, with the United States of America (USA), Brazil and China producing the vast majority of the total volume (pena-rosas, 2014). Zea mays also known as corn, is a large grain plant first domesticated by indigenous peoples in southern Mexico about 10,000 years ago. The leafy stalk of the plant produces separate pollen and ovuliferous in florescence or ears, which are fruits, yielding kernels or seeds (Lee, 2000).Maize has become a staple food in many parts of the world, with total production surpassing that of wheat or rice. However not all of this maize is consumed directly by humans. Some of the maize production is used for corn ethanol, animal feed and other maize products, such as corn starch and corn syrup. The six major types of corn are dent corn, flint corn, pod corn, popcorn, flour corn, and sweet corn (Lee, 2000). Maize has become a staple food in many parts of the world, with total production surpassing that of wheat or rice. Maize is known to provide high amount of energy, but not so in terms of its minerals and vitamin contents (Taiwo, 2016). Fortification is an efficient, simple and inexpensive strategy for supplying vitamins and minerals to the diets of large segments of the population (Chindo, 2012).Fortification of maize flour with vitamin A is recommended to prevent vitamin A deficiency in populations, particularly vulnerable groups such as children and women (Khedr, 2015).Although conventional food plants have the capabilities of providing most of the nutrients needed for energy, body building, maintenance and regulation of body processes, the need to explore some seemingly unappealing sources of nutrients have become imperative owing to the serious threat to growth, development and survival posed by increasing human population, food insecurity and economic crises in most developing nations like Nigeria (Santhi,2016). fortification is an efficient, simple and inexpensive strategy for supplying vitamins and minerals to the diets of large segments of the population, especially in low income communities in Africa where resources is very scare to purchase the expensive industrial fortified products (Chindo, 2012). This study set out to formulate and evaluate the effects of Maize flower fortification with different proportions of Carrot powder on proximate, phytochemical, mineral and vitamins compositions of the Maize.

MATERIALS AND METHODS

Study Area
The study area is Sabon Gari LGA of Kaduna state. Its headquarters are in the town of Sabon Gari. Sabon Gari local Government Area is located between longitude 11°N and latitude 7°E (Joshua *et al,* 2019). The climatic condition of Sabon Gari Local Government is made up of two seasons that is the dry and wet season; the dry season being October and end toward March and early April. It is followed by the period of heavy rainfall which is between the month of May and August. Each dry season is characterized by the dust cold dry wind of the Harmattan, towards late November to February. The rainfall sometimes come with heavy shower or down pour, which lead to collapse of buildings as most pond within the area got filled up. Most of the people of Sabon Gari Zaria are traders and farmer.

Sample Collections and Processing
Fresh carrot was collected from the farm market while the maize was collected from the open market in Sabon Gari local government area of Kaduna State in the month of August, 2018. The Carrot and maize were identified and their voucher number deposited at the Department of Biological Sciences, Ahmadu Bello University Zaria in Kaduna State. The fresh carrot was brought to the lab in a polyethene bags. The samples were washed with water, sought to remove dirty and then dried for 2h and then oven dried at 40° C for 11h. After obtaining a constant weight, it was pounded to powdery form using a mortar and pestle, while the dry Maize was brought to the lab in a polyethene bag and sorted. All were grinded and made into a powdery form with a mesh sieve of 0.1mm and sealed in a polyethene bag for analysis.

Table 1: Composition of Maize and Carrot Formulation

Blended proportions	Maize Flour (%)	Carrot Extract (%)
BP 1 (Control)	100	___
BP 2	80	20
BP 3	60	40

BP: Blend Proportions

Proximate Analysis
Proximate analyses (% crude protein, % fat, % crude fiber, % ash, % moisture content, and % carbohydrates) were determined on samples collected at 24-h interval using method described by AOAC (2005).

Determination of Phytochemicals
Flavonoid was determined using the procedure of Boham and Kocipai (1994). From oxalate through Day and Underwood (1986) procedure, phytin-phosphorus was determined by the method of Wheeler and Ferrell (1971) as modified by Reddy *et al.* (1978). Phytic acid was calculated by multiplying Phytin-P by the factor of 3.55 (Enujiugha and Olagundoye, 2001). The tannin content was determined by the quantitative method of Makker and Goodchild (1996). Alkaloid was determined using the procedure of Harborne (1973).

Determination of Minerals
The method of Mbaeyi and Onweluzo (2010) was used in analyzing minerals. Mineral analysis of samples taken from BP1, BP2, and BP3 sample preparations, sample digestion, and atomic absorption spectrophotometer (AAS) analysis.

Sample Digestion
Sample (0.67 g) was weighed into a glass beaker and 50ml of HNO_3: H_2O was added to it. The solution was heated in a fume cupboard with Bunsen burner applying gentle heat. The HNO_3 fumes were allowed to escape gradually until no more fumes were seen. This indicated the end of the digestion. The digested samples were then filtered into a 50ml standard flask and made up to volume with distilled water and ready for AAS analysis.

Atomic Absorption Spectrophotometer Analysis of Digested Samples
A standard curve was obtained for each of the minerals using the serially diluted concentration standards using an appropriate lamp particular to a given mineral which was mounted on the AAS. After obtaining the standard curve at a particular wavelength, the digested sample in the container was sucked into the AAS for analysis. At that wavelength which a particular mineral absorbed highest, the molecules were excited and moved to higher energy level. On returning back to their ground state, the excess energy absorbed and given off was observed as the concentration of the minerals. The different minerals analyzed, their lamps and individual wavelengths were potassium (K lamp; 766 nm), calcium (Ca lamp; 317 nm), sodium (Na lamp; 589 nm), (Zn lamp; 279 nm), and iron (Fe lamp; 259 nm)

Determination of Vitamin C
The modified method of the method adopted by Awolu *et al.* (2013) was used. The vitamin C content of the hydrophilic extracts from the sample was determined by the spectrophotometric method using ascorbic acid as a reference compound. Exactly 10.0ml of the juice sample was weighed into 10 ml of water and mixed together. 200 µl, that is, 0.2 ml of the extract was pipetted and mixed with 300 µl (0.3ml) of 13.3% of trichloro-acetic acid (TCA) and 75 µl (0.075 ml) of dinitrophenylhydrazyl (DNPH). The mixture was incubated in water bath at 37°C for 3 h. After 3h, 500 µl (0.5 ml) of 65% sulphuric acid was added and the absorbance was read with the spectrophotometer at 520 nm. The concentration of vitamin C was calculated as follows
Calculated as follows:

$$\frac{Absorbance\ of\ standard}{\text{Concentration of Sample}} = \frac{Absorption\ of\ sample}{Concentration\ of\ sample}$$

Determination of Vitamin A
Method of AOAC (2005) was used. Exactly 1 ml of the hydrophilic extracts from the sample was measured to the test-tube I (centrifugal) with a tight stopper and 1 ml of the KOH solution was added, the tube was plugged and shake vigorously for 1 min. The tube was heated in a water bath (60°C, 20 min), and was then cooled down in cold water. About 1 ml of xylene was added, the tube was plugged and shake vigorously again for 1 min. The tube was centrifuged (1500×g, 10 min), the whole of the separated extract (upper layer) was collected and transferred into the test tube II made of "soft" (sodium) glass. The absorbance A1 of the obtained extract was measured at 335 nm against xylene. The extract in the test tube II was irradiated to the UV light for 30

min, then the absorbance A2 was measured. The concentration (Cx) of vitamin A (μM) in the analyzed liquid was calculated using the equation:
Cx = [A1] – [A2]. 22.23

Where 22.23 is the multiplier received on basis of the absorption coefficient of 1% solution of vitamin A (as the retinol form) in xylene at 335 nm in a measuring cuvette, 1 cm thickness.

Statistical Analysis
SPSS version 20.00 was used for the analysis of data, while Anova (analysis of variance) and Turkey comparison test was used to check for variations among different blend formulations. Level of significance was taken when P ≤ 0.05

RESULTS AND DICUSSION

Results on Table 1, indicates the proximate compositions of different blend proportions of Carrot fortified Maize, the results clearly demonstrates a significant reduction (P<0.05) in the percentage Moisture, Crude fibre and Carbohydrates contents of BP1 (7.23±5.11), when compared to BP2 and BP3 (6.55±4.55, 6.44±4.62) and 8.16±5.7, 4.01±2.83, 3.37±2.38 and 73.64±52.06, 73.61±52.09 and 71.05±50.24. Table 1 also revealed no significant increase (P<0.05) in percentage Lipid contents between BP1,BP2 and BP3,while Table 1 demonstrates a significant increase (P<0.05) in the crude protein contents between BP2 and BP3(15.68±11.0, 17.43±12.3) when compared to BP1(10.06±7.11) respectively.

Table 2 clearly demonstrates the results of the phytochemical contents of unfortified and Carrot fortified Maize flour at different blend proportions. Table 2 indicates a significant reduction (P<0.05) in percentage Alkaloids, Flavonoids and Saponins of BP1 when compared to BP2 and BP3.Also Table 2 shows a significant increase (P<0.05) in percentage phytates, Oxalates and Tannins of BP2, BP3 when compared to BP3.
Table3 results indicates a significant increase (P<0.05) Sodium, Potassium, Calcium, Iron and Zinc compositions in BP2 and BP3 when compared to BP1.
Results on Tabl4 display the Vitamin A and C compositions in unfortified and Carrot fortified maize flour using different blend proportions in (Mg/l).Table 4 indicates a significant increase (P<0.05) in the Vitamin A and C contents of BP2, BP3 when compared to BP1.

Table1: Result of the proximate composition of unfortified and Carrot fortified Maize flour in (%)

Blending Proportion n = 3	Moisture	Ash	Lipid	Crude fiber	Crude protein	Carbohydrate
BP1(100)	7.23±5.11^b	2.49±1.76^a	0.87±0.61^a	8.16±5.7^b	10.06±7.11^a	73.64±52.06^b
BP2(80:20)	6.55±4.55^a	5.07±3.59^b	0.86±0.61^a	3.37±2.38^a	16.68±11.0^b	73.61±52.09^b
BP3(60:40)	6.44±4.62^a	6.92±4.89^c	0.88±0.62^a	4.01±2.83^C	18.43±12.3^c	71.05±50.24^a

Results are expressed as mean + S.D of mean, of triplicate determination n= number of formulations. Values in the same columns having the same superscript have no significant difference at P<0.05.

Table 2: Result of the phytochemical contents in unfortified and Carrot fortified Maize Flour in (%)

Blend Proportions n=3	Alkaloids	Flavonoid	Saponins	Phytates	Oxalates	Tannins
BP 1(100)	2.13±1.51^b	1.09±0.76^c	2.01±1.62^b	0.19±0.13^a	0.04±0.01^a	0.37±0.26^a
BP2(80:20)	2.68±1.18^a	2.40±0.49^a	2.22±1.39^a	0.11±0.14^b	0.02±0.01^b	0.22±0.67^c
BP3(60:40)	3.46±1.04^a	2.72±0.50^b	2.88±0.99^a	0.09±0.16^c	0.01±0.03^c	0.19±0.62^b

Key: Blend proportion (BP). Results are expressed as mean ± S.D of means of triplicate determination n= number of formulations. Values in the same columns having the same superscript have no significant difference at P<0.05

Table 3: Result of the mineral compositions in unfortified and Carrot fortified Maize Flour in mg/l

Blend Proportions n=3	Na	K	Ca	Iron	Zinc
BP 1(100)	4.3±0.30^a	5.9±0.41^a	3.3±0.22^a	1.27±0.90^a	0.21±0.14^a
BP2(80:20)	12.1±0.86^b	10.3±0.73^b	4.0±0.89^b	4.27±3.01^b	0.27±0.17^b
BP3(60:40)	20.6±1.46^c	16.3±1.15^c	7.0±0.50^c	10.19±7.19^c	O.45±0.31^c

Key: Blend Proportion (BP) results are expressed as mean + S.D of mean, of triplicate determination n= number of formulations. Values in the same columns having the same superscript have no significant difference at P<0.05.

Table4: Vitamin A and C compositions in unfortified and Carrot fortified Maize flour in (mg/l)

Blending Proportion (%) n=3	Vitamin A (mg/l)	Vitamin C (mg/l)
BP1 (100)	0.34±0.23^a	14.00±9.54^a
BP2 (80:20)	0. 62±0.43^a	17.00±11.31^b
BP3 (60:40)	0. 80±0.79^a	22.00±15.21^c

Key: Blend Proportion (BP) results are expressed as means ± S.D of mean, of triplicate determination n= number of formulations. Values in the same columns having the same superscript have no significant difference.

Table 1 results shows the proximate compositions of different blends of unfortified and Carrot fortified maize flower, table 1 demonstrates a significant reduction of moisture, Crude fibre and Carbohydrates contents in BP2 and BP3 when compared to BP1.The observed reduction in the moisture contents from BP1 to BP3 clearly indicate that the Carrot fortified maize flour would have good keeping quality and food spoiling micro flora cannot thrive in the presence of adequate moisture (Eno-Obong & Carnovale, 1992). The reduced moisture content is in line with report of Otunola, Sunny-Roberts, and Solademi (2007).). The recommended dietary allowance (RDA) for moisture in foods is ≤ 7% (FAO/WHO, 1998) and all the carrot fortified Maize flours, contain moisture contents within this range.

Table 1 demonstrates a significant (P<0.05) increase in the Ash contents as the quantity of carrot increases from BP1, BP2 and BP3 with BP1 having the least Ash content. The finding of increase in ash of Carrot fortified Maize flour is in line with the report of Modu *et al.,* 2013. Ajanaku *et al.,* 2013 and Mbata *et al*., 2009, also reported increases in ash content in their fortified products. Ash content of a food is a determinant of the mineral content of that particular food. The higher the ash content, the more the mineral content of the food (Ukegbu & Anyika, 2012). The recommended dietary allowance (RDA) for ash in foods is ≤5.0 mg/100 g (FAO/WHO, 1998) and all within this range.

There was slight increase in fat content observed during carrot fortification in this study. This is in line with Otunola *et al*. (2007) that showed increases in fat content of maize fortified flour. Increased fat content was also reported by Mbata et al. (2009). The slight improvement to the fat content in the carrot fortified maize flour may be due to increase in activity of lipolytic enzymes in the blend which hydrolyzes fat to glycerol and fatty acids (Modu *et al.,* 2013).). The fat requirement for neonates is essential for the development of brain especially for children under 2 years of age (Ajanaku *et al.,* 2013). The recommended dietary allowance (RDA) for fat in foods is ≥2.0 mg/100 g (FAO/WHO, 1998) and only the fortified products had fat contents within this range.

Crude fiber consists primarily of the indigestible complex carbohydrate of cell wall in plants. High dietary fiber can have some beneficial biological effects such as laxative effect on GIT, increased fecal bulk and help reduce plasma cholesterol level (Okoye, 1992). In this study, crude fiber values were found to be higher in the 100% Maize flour (BP1) than in the carrot fortified blend (BP2 and BP3) even though the results indicates a significant increase in crude fiber contents when BP3 was compared to BP2, this is in line with the that reported by Ewulo *et al*,2017. The recommended dietary allowance (RDA) for crude fiber in foods is 4.0 mg/100 g (FAO/WHO, 1998), implying that the crude fiber contents of BP2 and BP3 in this study meet the recommended allowance for infants.

The increase in crude protein indicated on table 1 reveals that the carrot fortified Maize flour has significant amount of crude protein content with increased carrot powder from BP2 to BP3 when likened to BP1 with 100% Maize flour. This perceived increase could be as a result of improvement in the protein content of the maize flour by the addition of Carrot powder. This is similar to the reports of Ijarotimi & Aroge, 2005; Modu *et al.,* 2013. Reports have also shown that protein quality is synergististically enriched in cereal-legume mixtures due to the impact of lysine by legume and methionine by cereal (Wakil & Kazeem, 2012). The recommended dietary allowance (RDA) for crude protein in foods is ≥16.0 mg/100 g (FAO/WHO, 1998) and BP2 and BP3 blend in this study had crude protein contents within this range, except the BP1(unfortified) 100% maize flour which was below the recommended range.

The reduction in carbohydrate content from BP1, BP2 and BP3 observed in this study agreed with the observation that addition of Carrot powder decreases the carbohydrate content of maize-based traditional foods (Mbata *et al.,* 2009; Sefa-Dedeh, Sakyi-Dawson, Afoakwa, Andoh-Kumi, & Tano-Debrah, 2001). The recommended dietary allowance (RDA) for carbohydrate in foods is ≥60 mg/100 g (FAO/WHO, 1998) and all, BP1, BP2 and BP3 are above these requirement.

The phytochemical contents of carrot fortified maize flour are presented on Table 2, the results clearly demonstrates a significant increase in Alkaloids, Flavonoids and Saponins and a significant reduction in Phytates, Oxalates and Tannins. The observed rise in Alkaloids, flavonoid and Saponins content with attendant rise carrot flour replacement is consistent with previous study that showed carrot as a good source of natural antioxidants (Dillard and German, 2000; Siddhuraju and Becker, 2003; Anwar *et al.,* 2005).Antioxidants are recognized for free radical scavenging ability (Scherer and Godoy, 2009) and therefore, neutralize free radicals that have the ability of stimulating reaction that make the cells more vulnerable to cancer causing chemicals, called carcinogen. The results also show a reduction in the phytates, Oxalates and Tannins, this is antinutrients. Antinutrients have the capacity of decreasing the digestibility and palatability of protein because they form insoluble complexes with them (Mbata *et al.,* 2009). Phytates are known to form complexes with iron, zinc, calcium, and magnesium making them less available and thus inadequate in food samples especially for children. Tannins are naturally occurring plant polyphenols. Their main characteristic is to bind and precipitate protein interfering with its digestion and absorption. It is known that 10–50 mg phytates per 100 g will not cause a negative effect on the absorption of zinc and iron (Pikuda & Ilelaboye, 2013). In this study, the phytates contents of BP2 and BP3, is within the safe consumption range. The tannin content of BP2 and BP3 in this study is generally low and is far lower than the lethal dose of 0.7–0.9 mg/100 g (Pikuda & Ilelaboye, 2013). This study shows that BP2 and BP3 formulation will contributes and allow the uptake of key micro and macronutrients due to their low antinutrients (phytates, oxalates, Tannins) contents when compared to 100% maize alone.

The mineral compositions in 100% maize flour (BP1) and Carrot fortified Maize flour (BP2, BP3) is presented in Table 3.The table demonstrates a significant increase in sodium, potassium, calcium, iron and zinc compositions with increase carrot powder mix to the maize flour. This has also been reported by Ukegbu and Anyika (2012).

The increase in mineral contents observed in table 3 is also authenticated by the increased ash content of BP2 and BP3 on table 1. A number of researchers (Adeyemi & Soluade, 1993; Enujiugha, 2006) also observed significant increase in ash and mineral contents in African oil bean–ogi and pawpaw–ogi, respectively

As specified in Ukegbu and Anyika (2012), the recommended dietary allowance of sodium for infants less than 1 year is 120 mg/100 g. Sodium, together with chloride functions in maintenance of extracellular fluids (keeping the water and electrolyte balance of the body) and blood pressure, and also required for nerve and muscle functioning (Oyarekua, 2011b).The results from the study shows that all the blend BP1, BP2 and BP3 are above the range of RDA 1.5g/day for sodium, these is in agreement with the findings of Okafor *et al,* 2018 who also reported same in their study.

Potassium is a vital nutrient needed for maintenance of total body fluid volume, acid and electrolyte balance, and normal cell function (Young, 2001). Low potassium intake has been associated with a lot of non- communicable diseases including hypertension, cardiovascular diseases, chronic kidney stone formation, and low bone-mineral density in children (WHO, 2003; WHO, 2012). As stated in Ukegbu and Anyika (2012), the recommended dietary allowance of potassium is 4.7g /day. The entire blend, BP1, BP2 and BP3 (5.9, 10.3 and 16.3g/day) gave potassium level above the range.

FAO/WHO (1998) reported the recommended dietary allowance (RDA) of calcium in adult food is 1.3g/day; BP1, BP2 and BP3 are above the (RDA.). Calcium in conjunction with phosphorus, magnesium, vitamin A, C, and D, chlorine, and protein are all involved in bone and teeth formation (Heaney RP, Recker RR, Watson P, Lappe JM.). It is also important in blood clotting, muscle contraction, and in certain enzymes in metabolic processes (Adeyeye & Fagbohun, 2005). Its deficiency can lead to rickets in children (Oyarekua, 2011b), a decrease in bone mass and the development of osteoporosis (Dickinson, 2004).

FAO/WHO (1998) reported the recommended dietary allowance (RDA) of zinc in adult food is 11mg/day; BP1, BP2 and BP3 are far below the (RDA.), Even though this study demonstrates a significant increase in zinc contents with increase addition of carrot powder ,(BP2 and BP3) when compared to BP1 respectively. Okafor *et al,* 2018 also reported similar findings in their study. FAO/WHO (1998) reported that zinc is required by enzymes for optimum metabolic activity and immune function.

An increased level of iron was observed in this study, from BP2 to BP3, this was also reported by Aremu, Olaofe, *et al.* (2011) and Aremu, Osinfade*, et al.* (2011). The recommended dietary allowance (RDA) for iron in adults' foods is 8 mg/day (Adeyeye & Faleye, 2004; FAO/WHO, 1998). Even thoughBP2 and BP3 had iron contents slightly below this range. A significant increase was observed when compared to BP1 with 100% Maize alone. Iron is a component of hemoglobin that transports oxygen to body tissues and is needed for red blood cell synthesis, respiration, and growth. Its deficiency can lead to anemic conditions in children (Dickinson, 2002).

Conclusions

The study showed that fortification of Maize flour with different proportions of Carrot powder enriched the nutritional quality of the maize flour. Moisture, ash, protein, fat, minerals and vitamins and phytochemicals contents all shows significant increases compared to the 100% maize flour and are within range and met the Recommended Dietary Allowance. Also the antinutrients (Phytates, Oxalates and Tannins) showed a significant reduction; as such the formulation will not affect the absorption of key nutrients.

Conflict of Interests

The authors have not declared any conflict of interests.

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