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ANTI NUTRIENT, ANTI OXIDANT AND MINERALS CONCENTRATION OF SCHOOL MEALS CONSUMED BY PRIMARY SCHOOL PUPILS UNDER THE SCHOOL FEEDING PROGRAMME IN KANO STATE, NIGERIA.

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ABSTRACT

The anti – nutrient properties of the meals shows 0.49%, 9.25mg/100g, 0.20%, 0.59mg/100g and 232.65mg/100g as the oxalate, Tannin, saponin, Cyanogenicglycocide, and phytate content respectively of KC, while 0.24%, 5.75 mg/100g, 0.43%, 0.59 mg/100g, and 200.30 mg/100g were that of KN and 0.29%, 17.50 mg/100g, 0.58%, 0.38 mg/100g and 381.54 mg/100g was that of KS. The phytate–minerals molar ratios of the meals shows that the values were relatively low when compared to the critical values.The anti –oxidant properties of the meals shows that 8.31, 13.08 and 2.75% were the flavonoid, total phenol and alkaloid content of KC respectively, 10.21, 8.99, and 4.08% was that of KN and lastly

Introduction:

School feeding programmes is the use of the schools or institution as instrument for the delivery and dispensation of food to school children (Sindama and Enyikwola, 2017). It has been introduced in many developed and developing countries of the world to address the issue of poverty, stimulate school enrolment and enhance pupils' performance (Taylor and Ogbogu, 2016). School feeding policies are a critical component of an effective education system,

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KS with 7.46, 26.29 and 3.48%. The low content of antinutrient could be due to the processing method applied to the food during processing. From the results it was observed that there is no significant difference (P< 0.05) on Phosphorous content of all the samples. A significant difference (P< 0.05) was observed between KC and "KN, KS" on sodium, copper, Potassium and Manganese content of all the samples. Magnesium, calcium, zinc and iron content of all the samples was significantly different (P< 0.05). This Research shows that,the School meals do not meet theone third of recommended daily energy and nutrient intakes (RNI). It is recommended that the schools should improve the nutrient intakes of the pupils by providing foods that will serve at least one third of recommended daily energy and nutrient intakes (RNI).Na/K, Ca/P ratio of the meal adequately met the WHO RDI, this indicate that given this food to the children will prevent them from becoming hypertensive and the meal will help in promoting bone development and teeth formation of the children.

Keywords: *School-meal, school children,anti-nutrients, ant-oxidants and minerals concentration.*

Given that children's health and nutrition, impact their school attendance, ability to learn, and overall development (Saber country report, 2015). According to **Republic of Kenya, National school meals and nutrition strategy (2017),** school meals are considered an important safety net for vulnerable children from food-insecure households and communities. The majority of the children who have no access to Primary education are from Poor households (Saber country report 2015).

School meals help to prevent a variety of chronic diseases such as high blood pressure, high cholesterol, diabetes, heart disease and certain cancers (Yeji, 2006). Providing school meals is therefore vital in nourishing children. Parents are motivated to send their children to school instead of keeping them at home to work or care for siblings (Akanbi, 2013). To ensure the extensiveness of school feeding programme as social safety net

in the world, at the beginning of 2020, national school feeding programmes delivered school meals to more children than at any time in human history (World Food Programme, 2020).

Impacts of school feeding programs on children's learning

Children who are hungry or chronically malnourished are less able to learn regardless of the setting, (Taylor and Ogbogu, 2016). It was found that School feeding program increase pupils participation in class assignment duties and discussion (Mohamed, 2015). School Feeding Programme in Osun State has increased the enrolment and improved the performance of elementary school pupils in the state, (Taylor and Ogbogu, 2016). Findings show that, 19.6 **%** of the respondents have strongly agreed that Dangote Foundation Social Feeding programme reduces late coming in formal school (Marafa and Uduji 2018). In-school meals have positive impact on girls learning and reasoning outcomes (Adamba, 2017).

Impact of school feeding programs on children's nutrition

Research showed that there is significant relationship between school feeding and health improvement among primary school pupil in Yobe State, Nigeria. There is also a significant relationship between food Hygiene and health improvement among Primary school pupils, and Food fed to school children afford them the opportunity to achieve all the nutrients (Sindama and Enyikwola, 2017). Proper diets may also affect learning potential, Inadequate and imbalanced diets may lead to restlessness, inattentiveness and hyperactivity in class, thus affecting children's performance and ability to learn. According to (Yeji, 2006), school meals help to prevent a variety of chronic diseases such as high blood pressure, high cholesterol level, diabetes, heart disease and certain cancers. Child feeding practice and quality health care are powerful factors that influence child growth and cognitive development (Ijarotimi and Enujiugha, 2008).

Anti-nutritional factors

Anti-nutrients are the key factor, which reduce the bioavailability of various components of the cereals and legumes (Samtiya *et al.,* 2020). Anti-nutritional factors are also regarded as anti- nutrients and they can be

natural or synthetic agent in foods that can interfere with the absorption of other nutrients (Abiola T., *et al*. 2018).Some of these anti-nutrients that have been called into question included lectins, oxalates, goitrogens, phytoestrogens, phytates, and tannins (Petroski and Minich, 2020). More recently, various research has questioned the healthfulness of plant-foods because of the presence of certain compounds, termed 'anti-nutrients'. These purported antinutrients, which include lectins, oxalates, phytates, phytoestrogens, and tannins, are thought to restrict bioavailability of key nutrients, while other studies conclude they may have health promoting effects (Petroski & Minich, 2020) The major nutritional problems in Nigeria are insufficient food intake and unbalanced food intake (Hassan *et al.* 2011).

Anti oxidants

An antioxidant can be defined as: "any substance that, when present in low concentrations compared to that of an oxidisable substrate, significantly delays or inhibits the oxidation of that substrate" (Young and Woodside, 2001). In other words, Antioxidants are substances or compounds that have free radical scavenging capacity while inhibiting oxidative progression (Rahaman *et al.*) 2020). Antioxidants prevent free radical induced tissue damage by preventing the formation of radicals, scavenging them, or by promoting their decomposition (Young and Woodside, 2001). It can also act by delaying or preventing the oxidation of other chemicals and are usually classified into enzymatic and non-enzymatic. The natural antioxidants are mainly plants, i.e., edible vegetables, fruits, spices, and herbs, which are rich in vitamins, phenolic compounds, carotenoids, and microelements (Flieger *et al.,* 2021).

A free radical can be defined as any molecular species capable of independent existence that contains an unpaired electron in an atomic orbital and the presence of an unpaired electron results in certain common properties that are shared by most radicals. Many radicals are highly reactive and can either donate an electron to or extract an electron from other molecules, therefore behaving as oxidants or reductants (Young and

Woodside, 2001). Radicals are generated within the initiation stage; they participate in a sequence of propagation reactions in which the number of radicals is constant; they are later on destroyed during the chain interruption stage (Butnariu and Samfira, 2012). Because radicals have the capacity to react in an indiscriminate manner leading to damage to almost any cellular component, an extensive range of antioxidant defences, both endogenous and exogenous, are present to protect cellular components from free radical induced damage (Young and Woodside, 2001).

Methodology

Data Collectionsand Determination of Nutritional Compositions of School Meals

Study Design and Data Selection Criteria

A list of primary schools in each of the Senatorial Districts in Kano State was obtained from the State Ministry of Education. Six Primary Schools comprising two primary schools from each of the three Senatorial districts were randomly selected for the study. A portion of the food samples were collected, pooled together according to senatorial District and analyzed for Anti nutrient, anti oxidant and minerals concentration.

Ethical Approval and Consent

Permission was obtained from the various Head Teachers of the selected schools. Written informed consent was obtained from parents/guardians of the selected pupils, and verbal consent from the pupils. This study was conducted with the approval of the ethics committee of school of agriculture, Federal University of Technology Akure with Ethics No. FUTA/SAAT/2019/013.

Determination of Nutritional Compositions of School Meals

Anti-nutrient composition of the samples

Determination of phytate composition: Phytate was determined according to the method described by Yahaya *et al*., (2013). About 4g of sample was soaked in 100 ml of 2% HCl for 3 hrs and then filtered through

a No 1 Whatman filter paper. Twenty five ml/litre was taken out of the filtrate and placed inside a conical flask and 5ml of 0.3% of ammonium thiocyanate solution was added as indicator. After which 53.5 ml of distill water was added to give it the proper acidity and this was titrated against 0.00566g per milliliter of standard iron (III) chloride solution that contain about 0.00195g of iron per milliliter until a brownish yellow colouration persist for 5min.

Determination of oxalate content:Oxalate determination was determined by soaking 1 g of the sample in 75 ml of 1.5N H_2SO_4 for 1hr and then filtered through a No 1 Whatman filter paper. 25 ml was taking out of the filtrate and placed inside a conical flask and was titrated hot between (80-90^{0}C) against 0.1m $KMnO_4$ until a pink colour that persist for 15 seconds (Day and Underwood, 1986).

$$Oxalate(mg/g) = \frac{(titrevaluexvolumeof\,KMnO_4xdilusionfactor)/5}{Samplesize}$$

Determination of saponins: Total saponin content (percent yield) was determined by gravimetric method as described by Kaur et al., (2015). The methanolic extracts from each plant (1 g in 10 ml) were macerated for 24 hours and then partitioned in a water and n-butanol (1:1 ratio) solution. This solution was poured into the separator funnel and kept for 2 hours. The upper n-butanol layer was separated and the solvent was evaporated to obtain crude saponin extract.

Determination of tannin (Folin-denis spectrophotometric method): A measured weight of each sample (1.0 g) was dispersed in 10 ml distilled water and agitated. This was allowed to stand for 30 mins at room temperature while continuously stirring every 5 mins. At the end of 30 mins, it was centrifuged and the extract obtained. 2.5 ml of the extract was dispersed into a 50 mL volumetric flask. Similarly, 2.5 ml of standard tannic acid was dispersed into a separate 50ml flask. A 1.0 mL Folin-Denis reagent was measured into each flask followed by the addition of 2.5 ml of saturated Na_2CO_3 solution. The mixture was diluted and made up to the 50 ml mark of the flask and was incubated for 90 mins at room temperature. The absorbance was measured at 250 nm in a UV spectrophotometer;

readings were taken with the blank sample at zero. The tannin content was given as follows; (Kingsley 2019).

% Tannin = An/As x C x 100/w x VF/VA

An= absorbance of the test sample
As = absorbance of standard solution
C = concentration of standard solution
W = weight of sample used
VF = total volume of extract
VA = volume of extract analyzed (Kingsley 2019).

Cyanogenetic glycosides (cyanide) alkaline titration method: This was carried out using the alkaline titration method of AOAC (AOAC 2012).. 10-20 g portion was placed, ground to pass No. 20 sieve in 80 ml Kjedahl flask, approximately 200 ml of water was added and allowed to stand for 2 to 4 hours (Autolysis was conducted with apparatus completely connected for distillation). Steam distilled, 150 to 160 ml distillate in NaOH Solution (0.5 g in 20 ml water) was collected, and diluted to definite volume (250 ml). To 100 ml distillate 8 ml 6M NH_4OH and 2 ml 5% KI Solution was added and titrated with 0.02M $AgNO_3$, using microburrete. End point was faint but permanent turbidity and was easily recognized, especially against black background.

1 Ml 0.02M $AgNO_3$ = 1.08g HCN (Ag equivalent to 2 CN).

Determination of anti-oxidants properties of the meals samples

Determination of total phenol:The total phenol content of the samples was determined by the method described by Singleton *et. al.,* (1999). 0.2mll of the extract was mixed with 2.5ml of 10% Folinciocalteau's reagent and 2ml of 7.5% Sodium carbonate. The reaction mixture was subsequently incubated at 45^{o}C for 40mins, and the absorbance was measured at 700nm in the spectrophotometer, gallic acid was used as standard phenol.

Determination of Total flavonoid: The total flavonoid content of the samples was determined using a colourimeter assay as described by Bao *et al.,* (2005). 0.2ml of the extract was added to 0.3ml of 5% $NaNO_3$ at zero time. After 5min, 0.6ml of 10% $AlCl_3$ was added and after 6min, 2ml of 1M

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NaOH was added to the mixture followed by the addition of 2.1ml of distilled water. Absorbance was read at 510nm against the reagent blank and flavonoid content was expressed as mg rutin equivalent.

Determination of alkaloids content: 5 g of the sample was weighed into a 250ml beaker and 200 ml of 10 % acetic acid in ethanol was added and allowed to stand for 4 hrs, this was filtered and extract was concentrated on a water bath to one quarter of the original volume. Concentrated ammonium hydroxide added drop wise to the extract until the precipitation was completed. The whole solution was allowed to settle and the precipitated was collected and washed with dilute ammonium hydroxide and then filtered. The residue is then alkaloid which was dried and weighed Sofowora , (1993)

$$\% \text{ Alkaloid} = \frac{W3 - W2}{W1} X\ 100$$

Determination of mineral composition of the meals samples

Determination of mineral composition: Calcium (Ca), magnesium (Mg), iron (Fe), copper (Cu) and zinc (Zn) were determined using Atomic Absorption Spectroscopy (AAS Model SP9). Sodium (Na) and potassium (K) of the meals samples was determined using flame emission photometer (Sherwood Flame Photometer 410, Sherwood Scientific Ltd. Cambridge, UK) with NaCl and KCl as the standards (AOAC 2012). Phosphorus was determined using Vanado-molybdate colorimetric method. The Na/K, Ca/P, Ca/Mg, molar ratios was also evaluated.

Statistical analysis

Statistical analysis was carried out using IBM Statistical Package for Social Sciences (SPSS), Descriptive statistics, i.e., frequency, percentages, and means (SEM) were used to summarize the variables. Chi-square was used to determine association between categorical variables, while comparison of means between male and female was done using the Student's t test. All tests were 2-tailed and significance was set at P-value less than 0.05.

RESULTS AND DISCUSSION

Table 1: Anti nutritional properties (mg/g) and Mineral PhytateMilimolar of the meals

Parameters	KC	KN	KS	Ref*
Oxalate (%)	0.49±0.46a	0.24±0.01a	0.29±0.02a	<2.5
Tannin (mg/100g)	9.25±0.35b	5.75±0.35c	17.50±0.71a	<300.00
Saponin (%)	0.20±0.00c	0.43±0.04b	0.58±0.04a	-
CynGly(mg/100g)	0.59±0.04b	0.82±0.05a	0.38±0.03c	<20.00
Phytate(mg/100g)	232.65 ±1.03b	200.30 ±0.36c	381.54 ±2.65a	<500.00
Phytate/Ca	0.77	0.81	0.76	<240
Phytate/Zn	246.37	184.36	408.43	<15,000
Phytate/Fe	18.76	21.59	351.88	<1,000

Values are Mean of triplicate determination ± S.D Different superscripts on the same row are significantly different (p≤ 0.05) according to Duncan Multiply range test.

Source ; (Ijarotimi *et al.,* 2022).

Key: KC = Food given to primary school's pupil of Kano central
KN = Food given to primary school's pupil of Kano North
KS = Food given to primary school's pupil of Kano South
CynGly= cyanogenic glycoside

Anti nutritional properties (mg/g) and Mineral Phytate Milimolar Of the meals

Table 1: Shows the anti nutritional properties of food given to primary school pupils in Kano state. The result of the Phytate content of the meals shows a significant different (p< 0.05) among all the samples. KS has the highest value followed by KC and KN with the lowest value. From the table, it was also observed that, there is no significant different (p< 0.05) of oxalate content of all the samples anda significant difference (p< 0.05) exist among the samples in terms of tannin, Saponin and Cyanogenicglucoside content of the meals. To predict the bioavailability of minerals, anti-nutrients to nutrients ratios were calculated. From the result, it was

observed that [phytate] / [Ca, Zn and Fe] ratios in the sample are below critical level.

Anti-nutritional factors are the compounds found in most food substances which are poisonous to humans or in some ways limit the availability of nutrient to the body (Thakur 2019**).** Oxalate, Saponin, Tannin,cyanogenic Glycoside and Phytate content of the meals were within the acceptable levels (Mune *et al.,* 2013). Acute cyanide poisoning can lead to growth retardation, and neurological disorder, and FAO/WHO confirmed 10 mg of HCN/kg dry weight as safe level (Nyirenda, 2020). Phytate, lecithin, tannins and saponin have been shown to reduce the blood glucose and insulin responses to starchy foods and / or the plasma cholesterol and triglyceride (Gemede and Ratta 2014). The phytate/mineral molar ratios: of the meal were within the acceptable levels. The value is an index of bioavailability of essential minerals on the meals thereby preventing anaemia, deformation of bones and poor cognitive development in children. This is in agreement with what was reported by Al Hasan *et al.,* (2016), who stated that phytate was one of the strongest inhibitory predictors of calcium, iron and zinc bioavailability. (Serna and Bergwitz, 2020) also confirmed that phosphorus in the body exists as extracellular matrix of bone and teeth. The inorganic part of hard tissues (bones and teeth) of mammals consists of calcium phosphate (Dorozhkin and Epple, 2002). Iron deficiency is extremely common in humans, and is the most prevalent cause of anemia worldwide and Iron deficiency, anemia rarely causes death (Miller, 2013). Zinc plays an ubiquitous role in human metabolism and its bioavailability is relatively higher in animal foods than plant based foods (Lokuruka, 2012).The low content of antinutrient could be due to the processing method applied to the food during processing. Phytic acid, tannins, alkaloids, saponins etc. are Heat-stable group and lectins, and cynogenic glycosides are heat labile group (Thakur 2019).

Table 2: Anti-oxidants content of the meals

Parameters	KC	KN	KS
Flavonoid (%)	8.31±0.14b	10.21±0.29a	7.46±0.20c
Total phenol (%)	13.08±0.45b	8.99±0.09c	26.29±0.69a
Alkaloid (%)	2.75±0.07c	4.08±0.11a	3.48±0.04b

Values are Mean of triplicate determination ± S.D Different superscripts on the same row are significantly different (p≤ 0.05) according to Duncan Multiply range test.

Key: KC = Food given to primary school's pupil of Kano central
KN = Food given to primary school's pupil of Kano North
KS = Food given to primary school's pupil of Kano South
CynGly= cyanogenic glycoside

Table 2: Shows the Antioxidants properties of the meals given to primary school pupils of Kano state. Antioxidants are substances or compounds that have free radical scavenging capacity while inhibiting oxidative progression Rahaman *et al.*) 2020). According to the finding described by (Flieger *et al.,* 2021) antioxidants act by delaying or preventing the oxidation of other chemicals. There was a significant different (p ≥ 0.05) on flavonoid, alkaloid and phenolic content of all the samples. A research by Wong *et al.,* (2002) shows high flavonoid content of drinks and confirmed the correlation of the content with highest antioxidant scavenging capability. Anti oxidants are involved in complex metabolic and signaling mechanisms of plants and animals life (Wilson *et al.,* 2017). Research shows that flavonoids have antioxidative activity, free radical scavenging capacity, coronary heart disease prevention, hepatoprotective, anti-inflammatory, anticancer activities and antiviral activities (Kumar and Pandey, 2013).Several research also confirmed biological actions and *in vitro* antioxidant activity and other beneficial effects of phenolics on human health (Minatel *et al.,* 2017). Many findings has shown the importance of antioxidants for maintaining the physiological functionsof some humanorgans and systems such as liver, kidney, digestive system, and the prevention of cardiovascular diseases and cancer has also been highlighted (Wilson *et al.,* 2017).

Table 3: Mineral composition (mg/100 g), Ca/P, Na/K ratio and WHO Ref* **of the meals**

Minerals	KC	KN	KS	Ref*
Sodium	58.86 ± 0.25^{b}	61.71 ± 0.41^{a}	62.09 ± 0.34^{a}	296
Magnesium	15.61 ± 0.24^{a}	12.99 ± 0.01^{c}	13.85 ± 0.21^{b}	76

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Phosphorous	116.54±21.62[a]	110.11±20.46[a]	124.79±23.90[a]	456
Potassium	343.87±7.07[b]	430.920±1.89[a]	439.69±0.74[a]	516
Calcium	181.82±0.25[b]	149.95±0.92[c]	303.00±0.01[a]	500
Zinc	0.93±0.04[b]	1.07±0.04[a]	0.92±0.01[b]	16
Iron	10.52±0.04[b]	7.87±0.17[c]	11.17±0.04[a]	16
Copper	0.92±0.04[a]	0.35±0.03[b]	0.34±0.03[b]	0.89
Manganese	3.04±0.36[a]	1.33±0.03[b]	1.61±0.15[b]	1.50
Na/K	0.17[b]	0.14[c]	0.49[a]	<1.00
Ca/P	1.56[b]	1.36[c]	2.43[a]	>1.00

Values are Mean of triplicate determination ± S.D Different superscripts on the same row are significantly different (p≤ 0.05) according to Duncan Multiply range test.
Source ; (Oluwajuyitan *et al.,* 2020).

Key: KC = Food given to primary school's pupil of Kano central
KN = Food given to primary school's pupil of Kano North
KS = Food given to primary school's pupil of Kano South

Mineral composition (mg/100 g), Ca/P, Na/K and WHO references of school meals

Table 3 shows the minerals concentration of food samples given to primary school pupils under the school feeding programme in Kano state. From the table it was observed that there is no significant difference (P< 0.05) on Phosphorous content of all the samples.A significant difference (P< 0.05) was observed between KC and "KN, KS" on sodium, copper, Potassium and Manganese content of all the samples. Magnesium, calcium, zinc and iron content of all the samples was significantly different (P< 0.05).According to (Ayogu *et al.,* 2018)School meals should improve the nutrient intakes of the pupils by providing a third of recommended daily energy and nutrient intakes (RNI).

Sodium/ potassium ratio and calcium/phosphorous ratio adequately met the standard, the low sodium potassium ratio of the food giving to the children of Kano State is an indication that the pupils will not be hypertensive. According to (WHO 2015), High salt consumption and insufficient potassium intake less than 3.5g contribute to high blood pressure, which in turn increase the risk of heart disease and stroke (WHO 2015). A reduction in sodium (as salt) consumption and increase in potassium intake is one of the most important strategies to reduce the burden of cardiovascular (Vasara *et al.,* 2017). Potassium can migrate the negative effects of elevated sodium consumption on blood pressure (WHO 2015). The calcium phosphorous ratio of the meal is higher than the reference value, which is an indication that the food giving to the pupils can help in promoting bone development and teeth formation. Which is in agreement with the findings of (Dorozhkin and Epple, 2002) who stated that, "phosphorus in the body exists as extracellular matrix of bone and teeth and the inorganic part of hard tissues (bones and teeth) of mammals consists of calcium phosphate".

Conclusion

School-aged children require adequate food in both quantity and quality that can provide energy, immunity, regulation of body processes, repair and maintenance of body tissues. Moreover the antioxidant scavenging capability andbioavailability of the variousminerals in the meals was observed,due to high antioxidants and low anti nutritional content of the meals. In addition, the mineral content of the meals was low. Hence, there is a need to improve the quality of the school-meals interm of minerals by inclusion of fresh fruit and vegetable per serving and fortified the school meals with essential minerals.This finding may be relevant to health and educational policy makers in Nigeria.

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