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Quality characteristics of cookies produced from composite flour of wheat incorporated with milkweed (*Asclepsias syriaca*) flour blend as a nutraceutical

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Abstract

The global awareness of good nutrition in combating some common illness is gradually increasing. Problem of typhoid has been on the increase in our society and most prophylactic drugs used are sometimes ineffective. Asclepsias syriaca or milkweed is one of such beneficial plants that has not been used for its curative purposes. Composite flour was formulated in the ratios, 100:0; 95:5; 90:10; 85:15. Cookies were made with these compositions. Proximate composition analysis showed the fat contents ranged between 6.14-8.24%, with highest fat value recorded in the 15% milkweed inclusion. Phytochemical analysis showed that alkaloids increase with increases in the milkweed substitution.The alkaloids present act as diuretic and it also has bactericidal and anti-malarial effect. Sensory analysis revealed increased dislike with increasing substitution of milkweed flour blend due to its bitter taste. Panelists experienced some purgative activities as a result of cookies blend consumption.

Keywords: Composite wheat flour; Milkweed flour blend; Diuretic; Nutraceuticals

1. Introduction

Cookies are popular snacks widely consumed all over the world by people of all ages and are traditionally made from soft wheat and are nutritious and convenience foods with long shelf life.

Asclepsias syriaca commonly called milkweed is named for its milky sap, which consists of latex containing alkaloids and several other complex compounds including cardenolides.*A. syriaca* has many uses in traditional medicines.

Common milkweed plant is part of the petro plant category by being a hydrocarbon yielding plant but is underexploited so far as a new agronomic crop with important potential industrial uses. The leaves and latex are described as having anti-cancer effect, wound-healing, diuretic, dysentery and gallstones remedy, according to [1].

Milkweed flour blend is to be used in preparation of cookies as a means of maximizing the nutraceutical application of milkweed qualities.

This work was carried out to enlighten the society in consumption of milkweed plant as to cure diseases such as typhoid, dysentery, etc

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2. Material and methods

Matured, blemish-free milkweed plant (*Asclepsias syriaca*) were collected from waterlogged areas on the Federal Polytechnic Campus Ado-Ekiti, and was confirmed from the Agronomy Dept. of Federal University Akure (FUTA). An App called Plant Snaps also confirmed the plant.

Wheat flour, sugar, Sodium bicarbonate, Baking fat and other materials were purchased from the market in Ado-Ekiti.

Sample cultivation and treatment: The plant was sorted, cleaned, oven-dried and then ground to powder.The leaves were dried using oven drying method at a temperature of 600^0C for 30 minutes to obtain dry leaves and then milled to get dried powder. The flour was used in formulating cookies in ratios, 100:0; 95:5; 90:10, 85:15, and packaged in air-tight labelled containers.

Proximate composition was determined using standard methods [2].

Phytochemical evaluation and sensory evaluation were determined using the appropriate methods. (ANOVA using SPSS version 21 and Duncan Multiple Range Test).

2.1. Production of cookies

The method used for the preparation of dough was the creaming method where fat and sugar were creamed together using the Kenwood mixer at medium speed for two minutes. After creaming flour, baking powder, milk, vegetables and spices were added and mixed until dough was well mixed. The dough was manually kneaded on a clean flat surface for 4minutes to ensure uniformity. It was manually rolled into sheets .The dough sheath was cut into round shapes using a cutter. Shaped dough pieces were transferred into greased pans and baked in an oven at 1800^oC for 20minutes. The baked cookies were placed on a cooling rack for minutes to cool before packaged for further analysis.

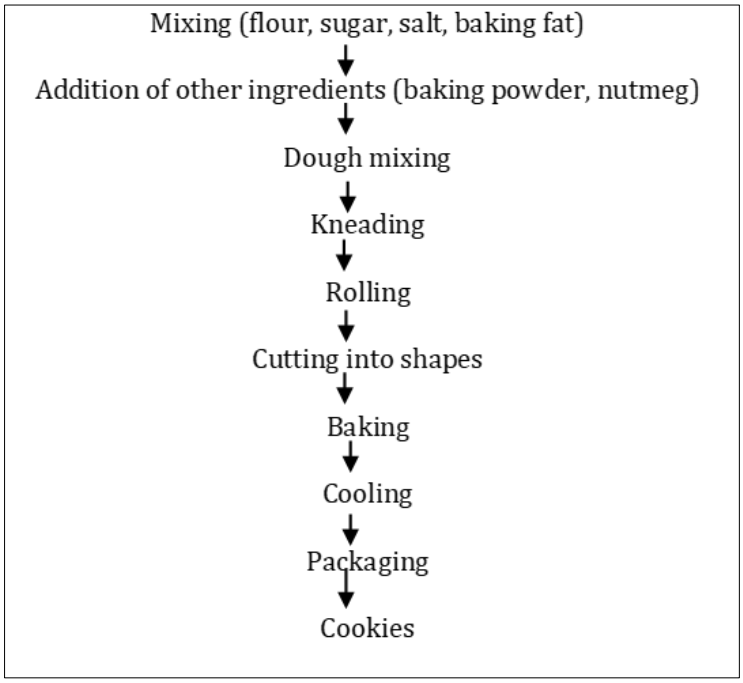

Figure 1 Flow diagram for the production of cookies (Eneche, 1999)

2.2. Method

2.2.1. Proximate composition of cookies

The proximate composition of the cookies was determined using the standard methods described by (AOAC, 2005). The parameters were moisture, ash, protein, crude fiber, Fat and carbohydrate content.

2.2.2. Moisture content determination

2.0g of the samples were placed in an oven maintained at 100-103^{o}c for 6 hours with the weight of the wet sample and weight after drying noted. The drying was repeated until a constant weight was obtained. The moisture content was expressed in terms of loss in weight of the wet sample

$$\% \text{ Moisture content} = (M1-M2)/ (M1-M0) \times 100$$

Where;

- MO = weight of dish and lid (g)
- M1 =weight of dish and sample before drying (g)
- M2 =weight of dish and sample after drying (g)
- M1-MO = weight of sample prepared for drying (g)

2.2.3. Ash content determination

2.0g of each of the oven-dried samples in powder form were accurately weighed and placed in crucible of known weight. These were ignited in a muffle furnace and ash for 8 hours at 5500c. The crucible containing the ash was then removed, cooled in a desiccators and weighed and the ash content expressed in term of the oven- dried weight of the sample.

$$\% \text{ Ash Content} = (\text{weight of ash})/ (\text{weight of sample (g)})$$

2.2.4. Protein content determination

The protein nitrogen in 1g of the dried samples was converted to ammonium sulphate by digestion with concentrated H2S04 and in the presence of CuSo4 and Na2SO4. These were heated and ammonia evolved was steam distilled into boric acid solution. The nitrogen from ammonia was deduced from the titration of the trapped ammonia with 0.1m HCL with Tashirus indicator (double indicator) until a purplish pink color was obtained. Crude protein was calculated by multiplying the value of the deduced nitrogen by the factor 6.25mg.

$$\% \text{ N} = (\text{Molarity of HCl} \times 0.014 \times \text{titre} \times \text{dilutionfactor})/100$$

2.2.5. Crude fibre determination

2.0g of each sample was weighed into separated beakers; the samples were then extracted with petroleum either by stirring, settling and decanting 3 times. The samples were then air dried and transferred into a dried 100ml conical flask. 200cm3 of 0.127M sulphuric acid solution was added at room temperature of the samples. The first 40cm3of the acid was used to disperse the sample. This was heated gently to boiling point and boiled for 30minutes. The contents were filtered to remove insoluble materials, which was then washed with distilled water, then with 1% HCL, next with twice ethanol and finally with diethyl ether. Finally the oven-dried residue was ignited in a furnace at 5500c .The fibre contents were measured by the weight after ignition and were expressed in term of the weight of the sample before ignition.

$$\%\text{crude fibre} = (A-B \times 100)/ (\text{weight of sample used})$$

A = weight of crucible and residue

A = weight of crucible and ash

2.2.6. Fat content determination

The lipid content was determined by extracting the fat from 10g of the samples using petroleum ether in a soxhlet apparatus. The weight of the lipid obtained after evaporating off the petroleum ether from the extract gave the weight of the crude fat in the sample.

$$\%\text{Fat} = (\text{weight of extracted fat} \times 100)/ (\text{weight of sample used})$$

2.2.7. Carbohydrate

The carbohydrate content of the samples were determined as the difference obtained after subtracting the values of Moisture, protein, fat, ash, and fiber from the total dry matter.

2.2.8. Sensory Evaluation

The sensory properties were determined using twelve panelists consisting of students from food technology department. Cookies samples prepared were presented and coded and placed on white plastic plate, using a nine point hedonic scale with a scale ranging from 1 to 9 with 1 representing the list scores (dislike extremely) and 9 the highest score (like extremely). The order of representation of samples was randomized. Sachet water was provided to rinse the mouth between evaluations. The panelists were instructed to evaluate the coded samples for colour, taste, flavor, texture and overall acceptability (Gernah, et al., 2010).

2.2.9. Statistical Analysis

All analysis was determined in triplicates and data were subjected to analysis of variance (ANOVA) using statistical package for social scientist (SPSS version 21) computer package. Mean were separated by Duncan's Multiple Range Test, significance was taken at $P \leq 0.05$. Error was reported as standard deviation from the mean.

2.3. Phytochemical determinations

2.3.1. Determination of total Alkaloids

5g of the samples was weighed in to 250 ml beaker and 200 ml of 10% acetic acid in ethanol was added and covered and allowed to stand for 4hrs. This was filtered and the extract was concentrated on a water bath to one quarter of the original volume. Concentrated ammonium hydroxide was added drop wise to the extract until the preparation was complete. The whole solution was allowed to settle and the precipitate was collected and washed with dilute ammonium hydroxide and filtered. The residue is the alkaloids which was dried and weighed.

2.3.2. Determination of Tannins

Tannin were extracted into boiling distil water for one hour. Color development was done with Follin-Dennis reagent and sodium carbonate solution. Absorbance was measured at 750nm spectrophotometrically. The tannin acid concentration was calculated from the tannic acid standard curve.

2.3.3. Determination of Saponin

Saponin was extracted for 2 hours in reflux condenser containing pure acetone. Exhaustive re extraction over heating mantle with methanol in the soxhletapparatus was done for 2 hours. Extract was weighed after allowing methanol to evaporate. The saponin content was calculated as percentage of the sample.

2.3.4. Determination of phenol

100mg of the sample was weighed accurately and dissolved in 100ml of triple distilled water (TDW). 1 ml of this solution was transferred to a test tube, then 0.5 ml 2N of the Folinciocalteu reagent and 1.5ml 20% of Na2Co3 solution were added and ultimately the volume was made up to 8ml with TDW followed by vigorous shaking and finally allowed to stand for 2 hours after which the absorbance was taken at 765nm. These data were used to estimate the total phenolic content using standard calibration curve obtained from various diluted concentrations of garlic acid.

2.3.5. Determination of flavonoids

The method is based on the formation of the flavonoids aluminum complex which has an absorptivity maximum at 415nm.100ul of 20% aluminum trichloride in methanol to 5ml. The absorption at 415nm was read after 40 minutes. Blank samples were prepared from 100 ml of plant extracts and a drop of acetic acid and then diluted to 5 ml with methanol. The absorption of standard rutting solution (0.5mg/ml) in methanol was measured under the same conditions. All determination was carried out in triplicates.

2.3.6. Determination of steroids

1ml of test extract of steroids solution was transferred into volumetric flasks. Sulphuric acid (4N.2 ml) and iron (III) chloride (0.5% w/v, 2ml) were added followed by potassium hexacyanoferrate (III) solution. The mixture was heated

in a water bath maintained at 700c for 30 minutes with occasional shaking and diluted to the mark with distilled water. The absorbance was measured at 780nm against the reagent blank.

2.3.7. Determination of glycosides

100ml of the purified & clear filtrate was transferred into Erlenmeyer flask. 10ml Baljet`s reagent was added. It was allowed to stand for one hour then diluted with 20ml distilled water and mixed properly. The intensity of the colour was obtained against the blank provided at 495nm with a spectrophotometer.

2.3.8. Determination of Terpernoids

About 10g of the sample powder was taken and soaked in alcohol for 24hrs. It was filtered and the filtrate was extracted with petroleum ether. The ether extract was treated as total terpernoids.

2.3.9. Determination of Cardiac Glycosides

Sodium picrate paper was prepared by dipping strips of filter paper into 1% picric acid solution and drying, then dipping into 10% Na2CO3 solution and drying. These papers are stored in stoppered bottle. Small amount of sample material was placed in test tube. Piece of moistened sodium picrate paper was inserted in tube, taking care that it did not come in contact with test sample. Few drops CHCL3 were added and stoppered tightly. The sodium picrate paper gradually turned orange, then brick red, indicated the presence of cardiac glycosides.

3. Results

Table 1 Proximate composition of wheat flour and milk weed flour blends

Sample	Moisture (%)	Ash (%)	Protein (%)	Fat (%)	Crude fibre (%)	Carbohydrate (%)
MLW/0	8.10±0.02^{d}	7.16±0.01^{d}	16.09±0.16^{d}	6.14±0.06^{d}	8.56±0.05^{d}	54.92±0.25^{a}
MLW/5	10.62±0.10^{b}	12.58±0.03^{a}	24.17±0.05^{b}	7.27±0.10^{b}	12.67±0.08^{a}	32.74±0.03^{c}
MLW/10	9.62±0.18^{c}	9.59±0.02^{b}	21.36±0.39^{c}	6.47±0.06^{c}	10.51±0.05^{c}	42.46±0.32^{b}
MLW/15	11.86±0.02^{a}	8.58±0.06^{c}	28.01±0.17^{a}	8.24±0.06^{a}	11.69±0.04^{b}	31.62±0.23^{d}

Mean ± standard deviations of triplicate determinations; Means in the same column with the same superscript are not significantly different (P > 0.05) Key: MLW0= 100% wheat flour; MLW5 =95% wheat flour +5%milkweed flour; MLW10 =90% wheat flour+ 10% milkweed flour; MLW15 =85%wheat flour + 15% milkweed flour

Table 2 Phytochemical analysis of cookies produced from wheat flour and milkweed flour blend

Sample	MLW0	MLW5	MLW10	MLW15
Alkaloids	8.38±0.01^{c}	8.38±0.01^{c}	12.18±0.11^{b}	13.04±0.41^{a}
Tannin	5.06±0.14^{c}	5.21±0.67^{c}	9.42±0.18^{b}	9.89±0.10^{a}
Phenol	36.87±0.39^{d}	40.51±1.15^{c}	49.60±0.10^{b}	54.18±0.05^{a}
Saponin	3.57±0.08^{d}	5.05±0.05^{c}	6.98±0.24^{b}	8.14±0.05^{a}
Steroid	4.01±0.08^{a}	0.19±0.03^{c}	0.10±0.01^{d}	3.16±0.02^{b}
Terpernoids	0.40±0.03^{d}	0.53±0.01^{c}	1.22±0.07^{b}	14.39±0.10^{a}
Flavonoids	2.91±0.26^{d}	8.60±0.02^{c}	10.49±0.36^{b}	14.39±0.10^{a}
Glycosides	0.89±0.04^{c}	1.11±0.03^{c}	10.48±0.15b	17.97±0.40^{a}
Cardiac glycosides	0.03±0.00^{c}	0.13±0.01^{c}	0.13±0.01^{c}	0.57±0.12^{a}
Reducing sugar	1.06±0.09^{d}	2.48±0.29^{c}	4.28±0.02^{b}	5.06±0.14^{a}

Mean ± standard deviations of triplicate determinations; Means in the same column with the same superscript are not significantly different (P > 0.05) Key: MLW0= 100% wheat flour; MLW5 =95% wheat flour +5%milkweed flour; MLW10 =90% wheat flour+ 10% milkweed flour; MLW15 =85%wheat flour + 15% milkweed flour

Table 3 Sensory Evaluation of cookies produced from wheat flour and milkweed flour blends

Sample	MLW/0	MLW/5	MLW/10	MLW/15
Colour	7.75±0.62[a]	6.50±0.91[a]	4.08±1.78b	3.58±2.27[b]
Flavour	7.17±1.11[a]	7.08±1.51[a]	4.83±2.52[b]	4.83±1.91[b]
Taste	8.33±0.65[a]	7.17±1.03[a]	4.50±1.88[b]	3.75±1.86[b]
Texture	7.75±1.06[a]	6.92±1.31[a]	4.33±1.15b	4.83±1.99[b]
Overall acceptability	8.00±0.60[a]	7.42±0.79[a]	4.91±0.90[b]	4.25±0.97[b]

Mean ± standard deviations of triplicate determinations; Means in the same column with the same superscript are not significantly different (P > 0.05) Key: MLW0= 100% wheat flour; MLW5 =95% wheat flour +5%milkweed flour; MLW10 =90% wheat flour+ 10% milkweed flour; MLW15 =85%wheat flour + 15% milkweed flour

4. Discussion

Table 1 shows the proximate composition of 100% wheat flour and different substitution indicates their proportion level of milkweed flour to form composite flours with the wheat flour. The moisture content ranged between 8.10 to 11.86%. It was observed that all the samples were significantly different ($p<0.05$) from one another. The least moisture content was found in sample in MLW/0 with the value of 8.10% which is 100% whole wheat and highest moisture content was recorded in sample MLW/15 which is the 15% substitution of milkweed flour. This is an indication that the samples with low moisture content will keep longer compare to others since moisture content increases deterioration in the food sample.

The fat contents ranged between 6.14 to 8.24%. There was significance difference ($p<0.05$) in all the samples. The highest fat value was recorded in the 15% milkweed flour substitution level of the composite flour while the low fat value was recorded in the control sample. The fat value was highest in sample MLW/15 (8.24%) while low fat value was observed in sample MLW/0 (6.14%). The high fat content may be due to the high fat content of milkweed which helps to increase the amount of fat in the cookies. The findings agrees with (3) and (4) on their reports for the increasing trend in the fat content of the cookies produced from wheat-defatted cashew nut and wheat – brewers spent grain (2.52-4.80%) flour blends respectively. The presence of high fat content in the cooking means high calorific value and also serves as a lubricating agent that improves the quality of the product, in terms of flavour and texture. High level of fat should be discouraged in food product to prevent rancidity.

The crude fiber ranged from 8.56% to 12.67% with the highest value observed in sample IK2 (5% milkweed flour substitution flour level) and low in the control sample. The findings conforms with the observation of (4), for the increasing trend in the crude fibre content of cookies made from wheat-brewers. This is appreciated in this study for its health benefits. Fiber aids in lowering blood cholesterol level and slows down the process of absorption of glucose, thereby helping in keeping blood glucose in control.

There was significance difference ($p<0.05$) in the carbohydrates contents across the samples. The carbohydrate ranged from 31.62 to 54.92%. The highest carbohydrate was found in the control and the least in the 15% substitution level. It was observed that as the milkweed flour substitution level increases the carbohydrate content increases. Similarly, a decreasing trend in the carbohydrate contents (73.46 – 46.20%) and (70.45-23.71%) of cookies made from wheat-brewers spent grain flour blends was reported by (4). The low fibre and carbohydrate content and increases fibre content of the composites cookies have several health benefits, as it aids digestion in the colon and reduces constipation often associated with product from refined grains reported by (5). It was observed that in the addition of the composite flour for each sample the carbohydrate content reduces, the reduction in the carbohydrate content in the cookies is vital in reducing the risk of diabetes when consume.

The protein content of the samples ranged from 16.09 to 28.01%. Significance difference was observed among the sample. It was observed that substitution of wheat flour with higher ratio (15%) of milkweed flour blends. The findings conform to the report of (4) that there is increase in the protein content with corresponding increases in the proportion of soy flour supplementation for cookies production from composite flour of wheat, plantain and soybean.

The ash content of the samples ranged between 7.16 to 12.58%. It was observed that the control samples with the ash content value of 7.16% has the least ash content value. However, the samples were significantly different ($p<0.05$) from one another. The substitutions of wheat flour with milkweed increase the ash content. The high ash content indicates

that there is tendency for high levels of minerals in the composites cookies produced. This is an indication that cookies produced from the composite flour blends of milkweed will provide more minerals to the consumers. The increases in the ash content is due fact that milkweed content is due to the fact that milkweed contains about 1.23% ash.

Table 2 shows the sensory quality of the cookies produce from 100% of wheat flour and different ration of milkweed flour blends. From the result it was observed that the control sample made with 100% was significant ($p<0.05$) higher compare to all other samples in all the attributes evaluated. This could be due to the fact the panelists were familiar with commercial cookies made with wheat flour.

The colour of the samples were significantly different ($p<0.05$) from one another. The control sample had the highest colour ratings. The scores for the cookies colour decreased as milkweed flour substitution increases. The change in color with increasing substitution level of milkweed flour blend could be due to the baking temperature and time. The results are in accordance with some findings reported that darker colour of cookies maybe due to the non- enzymatic reaction (Maillard reaction) between reducing sugar molecules and lysine protein. (6) also reported that darker colors are generally associated with enriched high fiber biscuits.

There was no significance difference in terms of flavour ratings for 10% and 15% substitution level of the composite flour. The degree of likeness decreases as the substitution level increases. The mean scores for flavour ranged from 4.48 to 7.17. The control sample was rated best while the 15% substitution level had the least value.

For the texture there was significance difference ($p<0.05$) across the samples. The control samples had the highest rating value in term texture. The least value was observed in sample MLW/15. The degree of likeness decreases has the level of substitution increases except for sample. The scores of the texture ratings ranged from 4.33 to 7.75.

The mean score for the overall acceptability ranged from 4.25 to 8.00. The reference sample had the highest value with the 15% substitution of the composite flour had the least value. The possible reason for low acceptability of the cookie samples produced with milkweed flour blends substitution level above 5% could be due to the dark brown, green coloration and bitter taste during the assessment of the samples were significantly different from each other. Sample with 100% and sample with 5% substitution has little significance difference.

Table 3 shows the result of the phytochemical analysis. The alkaloid content of the samples ranged from 8.16 to 13.04mg/g. The control samples had the least values of 8.1mg/g while the 15% substitution had the highest value of alkaloids .The alkaloids increases as the incorporation of milkweed flour to form a composite flour increases. Although the alkaloid content was lower than that of the upper limit of 60mg/100g recommended for a safe feed. Although their consumption should be moderate because of the active compounds present in them, it affects the central nervous system, reduces appetite and acts as diuretic and that it is bactericidal and anti-malaria when appropriate quantity is being used.

Tannins content of the cookies ranged from 5.06 to 9.89mg/g. There was a significant difference between the samples. The highest tannin level (9.89mg/g) was found in 15% substitution of the milkweed flour blend while the least value of (5.05mg/g) was observed in the control sample. The presence of tannins in the cookies contributes to the bitterness as it was noticed in higher substitution level sample. Although, appreciable amount of tannin has anti-bacterial effect.

There was significant difference ($p<0.05$) among the samples. The control samples have the saponin value of 3.57mg/g while at 15% milkweed flour in the composite flour of the highest saponin level of 8.14mg/g. The saponin ranged from 3.57 to 8.14mg/g. The high content in the 15% substitutional level could be due to high proportion of phytochemicals most especially the saponin in the plants. Despite the toxicity, saponins with little fraction is quite used as an antioxidants and therefore could serve as a potential active ingredients for nutraceutical functional foods as well as natural preservatives.

There was a significant difference among the samples. The control sample had the least, steroid value ranged between 0.19 to 4.0mg/g while at 15% substitution level with milkweed flour, the highest value of 4.01mg/g was noticed. The steroids value ranged from 0.19 to 4.0mg/g. It was observed that the steroid value decrease as the milkweed flour increases in the composite flour. Steroids are known to possess anti-bacterial and anti-neoplastic properties.

There was a significant difference ($p<0.05$) among all the samples. The flavonoid value ranged between 2.91 to 14.39mg/g. the highest value was observed in sample with 15% substitution level of milkweed flour in the composite flour and least value in the control sample. It was observed that flavonoids content increases as the milkweed flour

increases in the formulations. Some medicinal benefits attribute to the low level of flavonoid in food sample. Prevent oxidative cell damage and anti-inflammatory effect as reported by (7).

The glycosides content ranged between 0.89 to 17.97mg/g. There was no significant difference in the control sample and 15% milkweed flour substitution level. It was observed that the control sample had the least glycosides value of 0.89mglg while 15% substitution of milkweed flour had the highest value of 17.97mg/g.

The terpernoids value of the cookies ranged from 0.40 to 14.39mg/g. There was significant difference among the sample with 15% incorporation of milkweed flour in the formulations having the highest terpernoids content 14.39mg/g. When terpernoids are incorporated into flour at moderate dose hence, this could improve our nutritional profile even for both adults and infants.

The phenolic content of the sample ranged from 36.87 to 54.18mg/g. The reference sample (MLW/0) had the least value of phenolic content while sample MLW/15 (15% substitution) had the highest value of phenol. According to (8) dietary phenolic supplementation exert desirable outcome in complementary therapy when ingested in large quantity. From the reports of (9) confirmed that phenolics from T.cacao exhibited beneficial effects against aggregation, high blood pressure, hyperglycemia and hypercholesterolemia.

The value of the cardiac glycosides in the sample ranged between 0.03 to 0.57.the control sample had the least value while the sample (MLW/15) with the highest incorporation of milkweed flour blend had the highest. Cardiac glycosides in low doses serve as medication for cardiac disorders in humans as reported by (10).

5. Conclusion

The result obtained from this study showed that nutritious cookies and acceptable cookies were produced through substitution of wheat flour and milkweed flour blends. The phytochemical analysis of the cookies, the study revealed that the cookies contain appreciable amounts of nutrients such as protein, crude fibre, fat, ash (which indicates the presence of mineral matter) and carbohydrates. From the phytochemical analysis we can conclude that milkweed is important source of phytochemicals in which when incorporated as composite flour it increases the phytochemical characteristics of the cookies. The consumption of the cookies will provide essential nutrient and non-nutrient for human body which will serve as nutraceutical drug.

Cookies of composite flour supplemented with up to 5% to 10% milkweed flour were accepted in terms of sensory attributes.

Recommendation

The findings of the present study have clearly demonstrated the possibility of utilizing milkweed flour blends with wheat flour in the production of cookies. Therefore the composite flour could be recommended as a constituent of human diet with nutraceutical and pharmaceutical potentials and health benefits to the consumers. The food industries should been lightened on the production of nutraceutical food made from cookies. Composite flour technology must be introduced at mass level for constituent supply of nutritious and therapeutic food to the public. However, further research work should be focused on the shelf life stability of the cookies.

Compliance with ethical standards

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Disclosure of conflict of interest

The Authors hereby reiterate that there has been no conflict of interest in the publication of this project.

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