Plant Archives Vol. 25, Supplement 2, 2025 pp. 964-973 e-ISSN:2581-6063 (online), ISSN:0972-5210

Plant Archives

Journal homepage: http://www.plantarchives.org
DOI Url : https://doi.org/10.51470/PLANTARCHIVES.2025.v25.supplement-2.120

DEVELOPMENT OF NUTRITIOUS COOKIES USING LESSER YAM (*DIOSCOREA ESCULENTA*) FLOUR BLENDED WITH MORINGA LEAF POWDER AND PALM JAGGERY FOR A HEALTHIER ALTERNATIVE TO REFINED SUGAR BASED COOKIES

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(Date of Receiving-14-03-2025; Date of Acceptance-22-05-2025)

ABSTRACT

Dioscorea (yam) flour is utilized for the preparation of cookies along with Moringa leaf powder which improves nutritional value of cookies by value addition of Dioscorea flour. Hence, the present investigation "Development of nutritious cookies using lesser yam (*Dioscorea esculenta*) flour blended with moringa leaf powder and palm jaggery for a healthier alternative to refined sugar based cookies" was carried out at Department of Post Harvest Technology, College of Horticulture, Dr. Y.S.R. Horticultural University, Venkataramannagudem, Andhra Pradesh in a completely randomized design with 14 treatments based on the substitution levels of yam flour with wheat flour which are fortified with moringa leaf powder and replicated twice in the year 2022. The proximate composition for cookies were also evaluated. Fibre content of cookies ranges from 2.87 to 5.93 %, starch content of cookies ranges from 50.84 – 79.68 %, mineral (potassium) analysis is also done for cookies 0.177%- 0.271 %. Later all the treatments were subjected to sensory evaluation for colour, aroma, taste, flavour and overall acceptability and scores were recorded. Good quality and acceptable cookies are prepared with Dioscorea flour substituted from 10 per cent to 40 per cent with wheat flour and addition of moringa leaf powder up to 10 per cent is acceptable beyond that addition acceptability score for cookies decreases due to increase in the bitterness of cookies. Overall cookies incorporated with the above mentioned ingredients provide enhanced nutritional benefits, making them valuable for health oriented consumers. These findings support further development of functional food products that leverage the strengths of lesser yam flour and moringa leaf powder.

Keywords **:** cookies, Dioscorea , Moringa leaf powder, sugar free, palm jaggery.

Introduction

Cookies variations in flavour, crispness, and digestion make them an important choice for healthier snack selection. They are simple, affordable, and ready-to-eat food items that include vital dietary information and metabolism principles (Nwakalor and Chizoba 2014). Cookies are an excellent way to combine different food components that could be processed into nutrient-rich snacks which both adults and children love. Minerals including iron, magnesium, potassium, and calcium are among the many micronutrients found in palm jaggery that are normally lacking in refined sugar. On the contrary, refined sugar is regarded as a source of "empty calories," offering little to no nutritious value in the form of energy. According to a 2019 study by Mohan *et al*., palm jaggery has a glycaemic index (GI) of about 35 to 45,

which is significantly lower than that of refined sugar, which has a GI of about 60 to 65. Because of this, palm jaggery is used in current study which is a superior choice for controlling blood sugar.

On the other hand, *Dioscorea esculenta* is sometimes referred to as kangar, lesser yam, or Chinese yam. Yams are mostly made of carbohydrates, with trace amounts of vitamins, lipids, proteins, fibre, and essential amino acids. Along with these, it has significant levels of potassium, sodium, manganese, vitamin B, vitamin E, vitamin K, and beta-carotene. Vitamin C, which wheat lacks, is particularly abundant in yam. Because of its rich and comprehensive nourishment, Moringa oleifera is referred to as "The Miracle Tree" or "Tree for Life." Minerals, vitamins, and other vital phytochemicals are abundant in the leaves. Moringa leaves have a greater iron content (17.2 mg/100 g) than other vegetables. Furthermore, aspartic acid, glutamic acid, alanine, valine, leucine, isoleucine, histidine, lysine, arginine, phenylalanine, tryptophan, cysteine, and methionine are some of the amino acids found in Moringa leaves (Taher *et al*., 2017). Given its ease of use, affordability, and viability, the results of this study indicate that fortifying cookies with lesser yam flour moringa leaf powder and with palm jaggery a very successful way to increase the nutrients in children's diets. Therefore, it could be a good carrier for fortification.

Material and Methods

The present investigation entitled, "Development of nutritious cookies using lesser yam (*Dioscorea esculenta*) flour blended with moringa leaf powder and palm jaggery for a healthier alternative to refined sugar based cookies" was carried out at Department of Post Harvest Technology, College of Horticulture, Dr. Y.S.R. Horticultural University Venkataramanna gudem, West Godavari district, Andhra Pradesh. The cookies were prepared by using Dioscorea flour, moringa leaf powder and wheat flour in different proportions for value addition and commercial utilization of Dioscorea flour. The material and methods adopted during the course of investigation are presented below.

Preparation of Dioscorea flour

The pre-treated Dioscorea slices with water were drained and dried using tray drier to remove moisture content in slices. The slices are dissipated thinly on stainless steel trays which were kept in tray drier for dehydration. Dioscorea slices were dried at 60 °C. After cooling, the dried slices were pound in grinding machine and sieved to obtain fine flour. Flour samples were filled in 300 gauge polyethylene bags, sealed and labelled for further utilization.

Fig. 1 : Preparation of Dioscorea flour from tubers

Preparation of moringa leaf powder

After harvesting the fresh tender leaves, stems and stalks are discarded leaves are washed thoroughly for 2-3 times with fresh water and then spread on a kitchen napkin to absorb the extra moisture after that, spread on a sieve and allowed to dry in a tray drier at 60 °C for 1-2 days. The dried leaves were pound with miller to obtain fine powder and packed in air tight containers for further use.

Preparation of Cookies

Initially, baking machine was preheated to 200°C. The butter was beaten in a food mixer and powdered palm jaggery was added. Then, sieved flour sample as per treatment combinations was added into the mixture. The mixture was then mixed and kneaded until it became dough. The dough was cut into small uniform shaped cookies and placed on baking trays and baked in the oven at temperature of 200°C for 3-5 minutes until a golden brown colour was developed. They were allowed to cool and then packed in 400 gauge polyethylene bags and stored in cool and dry place and the data was recorded for different parameters.

FLOW CHART- I

Collection of flour, cream and jaggery powder

⬇

Preparation of composite flour as per the treatments

⬇

Creaming of fat and jaggery

⬇

Mixing of creaming mass, composite flour and baking powder

⬇

Molding

⬇

Baking at 200°C for 3-5 min

⬇

Cooling

⬇

Packaging in 400 gauge LDPE bags

⬇

Storage at ambient temperature

Procurement of Palm Jaggery

The quantity of palm jaggery required for preparation of cookies was procured from local market in Venkataramannagudem, West Godavari, Andhra Pradesh.

Treatment combinations

Ingredients (%)	T_1	T_2	T_3	T_4	T_5	T_6	T_7	T_8	T_9	T_{10}	T_{11}	T_{12}	T_{13}	T_{14}
Dioscorea flour	20	20	20	20	30	30	30	30	40	40	40	40	50	100
Moringa Leaf Powder	0	5	10	15	0	5	10	15	0	5	10	15	0	0
Wheat flour	80	75	70	65	70	65	60	55	60	55	50	45	50	0

Moisture content (%)

The moisture content was determined on percentage basis by infrared moisture analyzer (Make-Shimadzu; Model-MOC63u). The moisture content was recorded in percentage which is displayed directly on the instrument.

Dehydration ratio

The dehydration ratio is the product obtained from the weight of the fresh slices and dehydrated slices of yam which is calculated by using the following formula

$$\text{Dehydration ratio} = \frac{\text{Weight of fresh slices}}{\text{Weight of dehydrated slices}}$$

Recovery percentage of flour (%)

The recovery percentage of flour from tubers was worked out immediately after drying and before packing by taking the weight of raw product and weight of dehydrated product.

$$\text{Recovery}\,(\%) = \frac{\text{Weight of dehydrated product}}{\text{Weight of raw product}} \times 100$$

Total sugars (%)

The total sugars in the flour sample was determined by Lane and Eynon method (AOAC, 1965). A quantity of 50 ml lead free filtrate was taken in a 100 ml volumetric flask to which, 5 ml of concentrated HCl was added, mixed well and then kept for 24 hours at room temperature. Acid was then neutralized with NaOH using a drop of phenolphthalein as an indicator till the pink colour persisted for at least few seconds. Then volume was made up to 100 ml. Total sugars were then estimated by taking this solution in a burette and titrating it against standard Fehling's solution mixture of A and B (1:1) using methylene blue as an indicator taking brick red colour as an end point and total sugars were expressed in percentage.

$$\text{Total sugars}(\%) = \frac{\text{Factor} \times \text{Volume made up}}{\text{Titre value} \times \text{weight of sample}} \times 100$$

Reducing sugars (%)

Reducing sugars in Dioscorea flour were determined by Lane and Eynon method (AOAC, 1965). Twenty grams of sample was taken in a 250 ml volumetric flask. Two ml of lead acetate solution (45 %) was added to the flask for precipitation of colloidal matter and 2 milli litres of potassium oxalate (22 %) was added to this solution to precipitate the excess lead and the volume was made up to 250 ml using distilled water.

The precipitate was then filtered through whatman No. 1 filter paper to obtain lead free filtrate after testing a little of filtrate for its freedom from lead by adding a drop of potassium oxalate. Reducing sugars in the lead free solution was taken in burette and titrated against 10 ml of standard Fehling's solution mixture of A and B (1:1) using methylene blue as an indicator till the end point as indicated by the formation of brick red precipitate. The titration was carried out by keeping the Fehling's solution boiling on the heating mantle.

$$\text{Reducing sugars}(\%) = \frac{\text{Factor} \times \text{Volume made up}}{\text{Titre value}} \times 100 \times \text{Weight of the sample}$$

Non reducing sugars (%)

Non-reducing sugars in the flour sample were estimated by using the formula

Non-reducing sugars (%) = Total sugars – Reducing sugars

Estimation of starch (%)

Starch content in Dioscorea flour was estimated by Anthrone method

Preparation of standards

Standard glucose: Prepared by dissolving glucose in 100 ml water (stock solution).

Working standard: Prepared by diluting 10 ml of stock into 100 ml of water.

Methodology

Flour sample of 0.5 g was homogenized in hot 80 % ethanol to remove sugars. The homogenate is centrifuged and retain the residue. The residue was repeatedly washed with hot 80 % ethanol till the washings do not give colour with anthrone reagent. The residue was then dried over a water bath. To the residue 5.0 ml of water and 6.5 ml of 52 % perchloric acid was added and extracted at 0 □C for 20 min. Supernatant was centrifuged and repeated the extraction using fresh perchloric acid. Again, centrifuged and pooled the supernatants up to 100 ml. Pipette out 0.2 ml of the supernatant and made up to the volume to 1ml with water. Standards were prepared by taking 0.2, 0.4, 0.6, 0.8 and one millilitre of the working standard and made up the volume to one ml in each tube with water. Anthrone reagent of 4 ml was added to each test tube. Test tubes were heated for 8 min in a boiling water bath and cooled rapidly then read the intensity of green to dark green colour at 630 nm (Make -Systronics; Model - μc Calorimeter 115).

Calculation

Reducing sugars content in the sample was calculated using the standard graph. Starch content was calculated by multiplying the value by a factor 0.9.

% Starch = % Reducing sugars × 0.90

Estimation of protein content (%)

Protein content in Dioscorea flour was estimated Lowry's method

Preparation of Reagents

Reagent A: Prepared by dissolving 20 g of anhydrous sodium carbonate ($Na_2CO_3.2H_2O$) and 4 g of sodium hydroxide in 1000 ml of distilled water.

Reagent B: Prepared by mixing 1 ml of 1.35 per cent sodium potassium tartarate and 0.1 ml of 5.5 per cent copper sulphate ($CuSO_4.5H_2O$) solutions.

Reagent C: Alkaline copper solution was prepared by mixing 50 ml of reagent A with 1 ml of reagent B just before use.

Reagent D: prepared by mixing Folin-Ciocalteau phenol reagent with distilled water at a ratio of 1:1.

Preparation of Standards

A stock solution was prepared by dissolving 50 mg of Bovine Serum Albumin (BSA) in distilled water and the final volume was made up to 50 ml in a volumetric flask. ten ml of stock solution was taken in another volumetric flask and volume was made up to 50 ml. From the working standard, different concentrations were prepared.

Extraction of protein from sample

Extraction is usually carried out with buffers used for the enzyme assay. 500 mg of the sample was Weighed and grinded well with a pestle and mortar in 5 ml of the buffer. Centrifuge and use the supernatant for protein estimation.

Procedure

Different concentrations of working standard solutions were pipetted out in series of test tubes later 0.1 ml and 0.2 ml of the sample extract were pipetted out in two other test tubes made the volume to one millilitre in all test tubes. A tube with one ml serves as a blank and add five millilitre of reagent C to each test tube including the blank. Mix well and allowed to stand for 10 minutes. Then 0.5 ml of reagent D added, mix well and incubate at room temperature in dark for 30 min blue colour is developed. The colour intensity was measured at 660 nm with colorimeter (Make – Systronics; Model - µC Calorimeter 115) the amount of protein in the sample was calculated by using standard graph.

Calculation

From the standard curve, concentration of protein content is expressed in percentage.

Estimation of fibre (%)

The fibre percent was estimated in sample using the procedure as laid out by AOAC, (2005).

Procedure

Two grams of moisture and fat free sample was taken in 500 ml beaker and 200 ml of 1.25 % H_2SO_4 was added. It was boiled for half an hour, cooled and filtered through muslin cloth. Residue was washed several times with hot distilled water and transferred to a beaker after checking for being acid free. Later 200 ml of 1.25 % NaOH solution was added. The contents were boiled for half an hour, cooled and filtered through muslin cloth and washed with hot distilled water for number of times till it becomes free from alkali. Residue was transferred to a weighed crucible and dried to constant weight at 100 ^{o}C in hot air oven. The residue was then held in muffle furnace at 550 ^{o}C ± 20 ^{o}C for 3 hours, cooled and weighed again. The loss in weight was recorded. The per cent fibre was calculated by using the formulae.

$$\text{Fibre}\,(\%) = \frac{\text{Weight of residue before ignition} - \text{weight of ash after ignition}}{\text{Weight of sample}} \times 100$$

Estimation of Ascorbic acid (mg 100 g^{-1})

The ascorbic acid content in Dioscorea flour was determined by 2, 6-dichlorophenol indophenol visual titration method as followed by Ranganna (1986) and expressed in mg 100 g^{-1}.

Preparation of 2, 6- dichlorophenol indophenol dye solution

Fourty two milligrams of sodium bicarbonate was weighed into a small volume of distilled water and fifty two milligrams of 2, 6- dichlorophenol indophenol was dissolved in it and made up to 200 ml with distilled water.

Preparation of 3 % metaphosphoric acid

Thirty grams of metaphosphoric acid was dissolved in a small quantity of distilled water and the volume made up to 1000 ml.

Procedure

Ten grams of freshly ground sample was blended with three per cent metaphosphoric acid and made up to 50 ml with three per cent HPO_3. The contents are filtered through Whatman No.1 filter paper. Ten ml of the HPO_3 extract was taken and titrated against standard 2, 6-Dichloro phenol indophenol dye to a pink end point (Ranganna, 1986).

$$\frac{\text{Ascorbic acid}}{(\text{mg}\,100\,\text{g}^{-1})} = \frac{\text{Titre value} \times \text{Dye factor} \times \text{Volume made up}}{\text{Volume taken} \times \text{Weight of the sample}} \times 100$$

Estimation of potassium (%)

Procedure

Triple acid extract of five ml was taken and to this five ml of ammonium hydroxide (1:4) was added for neutralization. Fed up the contents directly to the flame photo meter after adjusting the flame photometer to zero with blank and standardizied with 100 ppm of potassium solution with 100 galvanometer readings. Galvanometer readings were noted and read the corresponding ppm from the standard curve drawn for the meter. From the ppm, the percentage of total potassium in the given sample was calculated (Make - Systronics; Model - µC Flame photometer 218).

Calculation

From the standard curve, potassium content in different entries was estimated

$$= \frac{\text{PPM}}{10^6} \times \text{V} \frac{100}{\text{W}} \times \frac{100}{100 - \text{M}}$$

Where:

M = Moisture content of the plant sample.

W = Weight of the sample taken, V = Volume made up to

ppm = Content of K in plant material with reference to the standard graph

Organoleptic evaluation

Cookies prepared under varied treatments was evaluated for sensory characteristics viz., colour, aroma, texture, taste and overall acceptability. Each attribute was given a separate score of 9 points. From the quality point of view, higher product scoring was treated as more acceptable. Sensory evaluation with a panel consisting of five panelists and instructed to evaluate the sample as per hedonic scale procedure.

Results and Discussion

The observations recorded for moisture, fibre, protein, starch, potassium, vit – C, of cookies produced from composite flour of lesser yam, moringa leaf powder and palm jaggery are presented in Table 2.

1. Moisture (%)

The observations recorded for moisture content of flours used in the recipe preparation and cookies prepared with blends of the flours are presented in Table 1 & 2 respectively. The moisture content of lesser yam flour (10.80) per cent and (8.96) per cent in moringa leaf powder was recorded and this observation are in accordance with the findings of Uthumporn *et al.* (2017) in cassava flour and in sweet potato flour by Olatunde *et al.* (2015).

Among treatments, significant increase in the moisture content was observed during baking operation. The moisture content of cookies ranges from 4.34 to 10.12 per cent. The lowest moisture content of 4.34 % was observed in T_1 cookie prepared with combination of (20 DF : 0 MP : 80 WF) followed by T_2 of 4.95 % and highest moisture content of 10.12 % was recorded in T_{14} (100 DF : 0 MP : 0 WF) followed by T_{13} of 9.89 % in cookies prepared with palm jaggery. The increase in moisture content of cookies from T_1 to T_{14} might be due to hygroscopic nature of flour and jaggery used in product preparation. These results are in accordance with the findings of Sadhu *et al.* (2013) in cookies prepared with carrot flour and in sweet potato flour cookies by Adeyeye *et al.* (2014).

2. Fibre (%)

The observations recorded for fibre content of flours used in the recipe preparation and cookies prepared with blends of the flours are presented in Table 1 & 2 respectively. The fibre content of lesser yam flour (3.64) per cent and (7.86) per cent in moringa leaf powder was recorded. Similar results were also reported in cassava (*Manihot esculenta*) flour by Uthumporn *et al.* (2017) and in mixture of yam flour and soya bean pomace flour by Emmanuel *et al.* (2019).

Among treatments, significant increase in the fibre content was observed up to certain extent due to increase in moringa leaf powder substitution. The fibre content of cookies ranges from 2.87 to 5.93 per cent. The highest fibre content of 5.93 % was observed in T_{12} cookies prepared with combination of (40 DF : 15 MP : 45 WF) followed by T_8 of 5.69 % and lowest fibre content of 2.87 % was recorded in T_1 (20 DF : 0 MP : 80 WF) followed by T_5 of 2.95 % in cookies prepared with palm jaggery. Similar results were observed in cookies prepared with cashew nut flour and wheat flour by Ojinnaka and Agubolum (2013) and in cookies prepared with cocoyam flour and wheat flour by Igbabul *et al.* (2015).

3. Protein (%)

The observations recorded for protein content of flours used in the recipe preparation and cookies prepared with blends of the flours are presented in Table 1 & 2 respectively**.** The protein content of lesser yam flour was found to be (3.50) per cent similar findings were also reported in flour of yellow colour cultivar of *Dioscorea bulbifera* by Ojinnaka *et al.* (2017) and in sweet potato (*Ipomoea batatas*) flour by Olatunde *et al.* (2015) and in moringa leaf powder it is of (23.42) per cent similar results were also reported in nutrient composition of moringa on its estimation by Machado *et al.* (2010).

Among treatments, protein content of cookies ranged from 12.72 % to 31.24 % the highest protein content of 31.24 % in T_{14} (100 DF : 0 MP : 0 WF) followed by 28.76 % in T_{12} and lowest protein content of 12.72 % was recorded in T_1 (20 DF : 0 MP : 80 WF) followed by 13.83 % in T_5 in cookies prepared with palm jaggery. Similar results were also reported in cookies prepared with blending of wheat flour and African yam bean flour by Idowu (2014) and in cookies prepared with blends of wheat flour, coco yam flour and african yam bean flour by Igbabul *et al.* (2015).

4. Starch (%)

The observations recorded for starch content of flours used in the recipe preparation and cookies prepared with blends of the flours are presented in Table 1 & 2 respectively**.** The starch 74.30 % similar results were also reported in palmyra young shoot flour by Thivya *et al.* (2018) and in flours of taro (*Colocasia esculenta*), yam (*Dioscorea sps*) and sweet potato (*Ipomoea batatas*) by Aprianita *et al.* (2009) and in moringa leaf powder starch content is of 58.29 %. These findings are in accordance with Adegunwa *et al.* (2010) in moringa leaf powder.

Among treatments, starch content of cookies ranges from 50.84 % to 79.68 % the highest starch content of 79.68 % in T_{14} (100 DF : 0 MP : 0 WF) followed by T_{13} and lowest fibre content of 58.72 %

was recorded in T_1 (20 DF : 0 MP : 80 WF) followed by T_4 of 50.84 % in cookies prepared with palm jaggery. Similar results were also reported biscuits prepared with blending of wheat flour and African yam bean flour by Idowu (2014).

5. Vitamin - C (mg100 g^{-1})

The observations recorded for vitamin C content of flours used in the recipe preparation and cookies prepared with blends of the flours are presented in Table 1 & 2 respectively. The vit C content of 20.34 mg100 g^{-1} was recorded in Dioscorea flour similar results were also reported in sweet potato flour by Lu *et al*. (2020) and in flours of *Dioscorea rotundata* and *Dioscorea alata* by Adebowale *et al*. (2018). In moringa leaf powder vit C content of 132.35 mg100 g^{-1} was recorded similar results were also reported in moringa leaf powder on its estimation by Kowsalya and Vidhya (2004)

Among treatments, Vitamin C content of cookies ranges from 12.91 to 19.18 mg 100 g^{-1} highest vit C content was recorded in T_{14} (100 DF : 0 MP : 0 WF) of 19.18 followed by T_{13} and lowest Vitamin C content of 12.91 mg 100 g^{-1} was recorded in T_1 (20 DF : 0 MP : 80 WF) followed by T_2 in cookies prepared with palm jaggery. Similar results were also reported in cookies prepared with blends of wheat flour, carrot pomace powder and fenugreek leaf powder by Thungchano *et al*. (2020) and in cookies prepared with blends of native potato starch, wheat flour and moringa seed flour by Obioma *et al*. (2021).

6. Potassium (%)

The observations recorded for potassium content of flours used in the recipe preparation and cookies prepared with blends of the flours are presented in Table 1 & 2 respectively. The potassium content of 0.897 % was recorded in Dioscorea flour. Similar results were also reported in flour of sweet potato by Ernest *et al*. (2018) and in flour of cassava (*Manihot esculenta*) by Lu *et al*. (2020). In moringa leaf powder potassium content of 2.32 % was recorded. Similar results were reported in dried moringa leaf powder on its estimation by Moyo *et al*. (2011).

Among treatments, potassium content of cookies ranges from 0.177 % to 0.271 %. Highest potassium content of 0.271 % was recorded in T_{12} (40 DF : 15 MP : 45 WF) followed by T_8 and lowest potassium content of 0.177 % was recorded in T_1 (20 DF : 0 MP : 80 WF) followed by T_5 in cookies prepared with palm jaggery. Similar results were also reported in cookies prepared with flour blends of carrot, lupin and barley by Herminia *et al*. (2017) and in cookies prepared with blends of cassava flour and kale leaf powder by Hasrini *et al*. (2021)

7. Sugar content of the flours

The percentage of total sugars of 13.63 was recorded in Dioscorea flour. Similar results were also reported in yam flour by Fakorede *et al*. (2020) and in yellow and red fleshed yam flour by Leng *et al*. (2019). The total sugars percentage of 34.39 was recorded in moringa leaf powder in the present experiment. The similar results were also reported in moringa leaf powder on its estimation by Joshi and Jain (2011).

The percentage of reducing sugars of 3.18 was recorded in Dioscorea flour. The similar results were also reported in yam (Dioscorea rotundata) flour by Fakorede *et al*. (2020) and in cassava (Manihot esculenta) flour by Otache *et al*. (2017). The reducing sugars percentage of 25.63 was recorded in moringa leaf powder in the present experiment. The similar results were also reported in moringa leaf powder on its estimation by Prabhu *et al*. (2011).

The percentage of non-reducing sugars of 10.45 was recorded in Dioscorea flour. The similar results were also reported in cassava (Manihot esculenta) flour by Otache *et al*. (2017) and in sweet potato (Ipomoea batatas) flour by Srivastava *et al*. (2012). The non-reducing sugars percentage of 8.76 was recorded in moringa leaf powder in the present experiment. The similar results were also reported in moringa leaf powder on its estimation by Adeyemi *et al*. (2011).

Table 1 : Proximate composition of flours used in the recipe

S. No	Parameters	Dioscorea flour	Moringa Leaf Powder
1.	Total sugars (%)	13.63	34.39
2.	Reducing sugars (%)	3.18	25.63
3.	Non reducing sugars (%)	10.45	8.76
4.	Starch (%)	74.30	58.29
5.	Protein (%)	3.50	23.42
6.	Fibre (%)	3.64	7.86

7.	Phenolic content (mg GAEg-1)	7.19	14.72
8.	Vitamin – C (mg100 g^{-1})	20.34	132.35
9.	Potassium (%)	0.897	2.32
10.	Moisture (%)	10.80	8.96

Table 2 : Proximate composition of cookies

Treatments	Moisture (%)	Fibre (%)	Protein (%)	Starch (%)	Vit – C (mg 100 g^{-1})	Potassium (%)
T_1 - 20(DF) : 0(MP) : 80(WF)	4.34^{a} (2.31)	2.87^{a} (1.96)	12.72^{a} (3.73)	58.72^{e} (50.00)	12.91^{a}	0.177^{a} (1.085)
T_2 - 20(DF): 5(MP) : 75 (WF)	4.95^{ab} (2.43)	3.79^{b} (2.18)	14.95^{b} (4.03)	56.24^{d} (48.56)	13.45^{ab}	0.193^{a} (1.092)
T_3-20(DF) :10(MP) : 70(WF)	5.39^{b} (2.52)	4.54^{c} (2.35)	17.34^{c} (4.32)	53.12^{c} (46.77)	13.98^{b}	0.216^{b} (1.103)
T_4-20(DF):15 (MP) : 65(WF)	5.84^{bc} (2.61)	5.48^{d} (2.54)	19.43^{cd} (4.56)	50.84^{b} (45.46)	14.44^{bc}	0.230^{b} (1.109)
T_5 - 30(DF) : 0(MP) : 70 (WF)	6.13^{c} (2.67)	2.95^{a} (1.98)	13.83^{ab} (3.88)	66.39^{h} (54.55)	14.96^{bc}	0.184^{a} (1.088)
T_6-30 (DF) : 5 (MP) : 65(WF)	6.57^{cd} (2.75)	3.91^{b} (2.21)	16.78^{c} (4.25	64.17^{g} (53.21)	15.64^{cd}	0.199^{ab} (1.095)
T_7-30(DF):10 (MP) : 60(WF)	6.98^{d} (2.82)	4.72^{c} (2.39)	20.20^{d} (4.64)	60.33^{f} (50.94)	15.92^{cd}	0.229^{b} (1.109)
T_8-30(DF):15 (MP) : 55(WF)	7.43^{de} (2.90)	5.69^{d} (2.58)	24.67^{e} (5.11)	58.70^{e} (49.99)	16.38^{d}	0.250^{c} (1.118)
T_9-40(DF) : 0 (MP) : 60 (WF)	8.06^{e} (3.01)	3.08^{a} (2.01)	15.62^{b} (4.11)	74.40^{j} (59.59)	16.98^{de}	0.198^{ab} (1.095)
T_{10}-40(DF): 5 (MP) : 55(WF)	8.47^{ef} (3.07)	4.12^{b} (2.26)	18.37^{c} (4.44)	70.68^{i} (57.19)	17.32^{e}	0.219^{b} (1.104)
T_{11}-40(DF):10(MP): 50 (WF)	9.13^{f} (3.18)	5.07^{c} (2.46)	23.29^{e} (4.97)	68.37^{i} (55.76)	17.87^{e}	0.242^{c} (1.114)
T_{12}-40(DF):15(MP): 45 (WF)	9.46^{f} (3.23)	5.93^{d} (2.63)	28.76^{f} (5.50)	66.92^{h} (54.87)	18.41^{ef}	0.271^{d} (1.127)
T_{13}-50(DF):0 (MP) : 50 (WF)	9.89^{fg} (3.30)	4.72^{c} (2.39)	26.43^{e} (5.28)	77.41^{k} (61.61)	18.62^{f}	0.213^{b} (1.101)
T_{14}-100(DF):0(MP):0(WF) (control)	10.12^{g}(3.33)	4.19^{b} (2.27)	31.24^{f} (5.73)	79.68^{k} (63.19)	19.18^{f}	0.238^{c} (1.113)
Mean	7.34 (2.86)	4.36(2.30)	20.25(4.61)	64.71(53.69)	16.14	0.218(1.103)
SE(m) ±	**0.025**	**0.056**	**0.109**	**0.816**	**1.301**	**0.002**
C.D at 5%	**0.078**	**0.173**	**0.333**	**2.499**	**3.947**	**0.006**

*DF – Dioscorea flour, *MP – Moringa leaf powder, *WF – Wheat flour,
Note: Values in parenthesis are square root transformed values

The data recorded for colour, Aroma, Texture, Taste, Overall acceptability of cookies as influenced by treatments with preparation palm jaggery is presented in table 3.

Highest score for colour of 8.9 in T_6 (30 DF : 5 MP : 65 WF) and the lowest score for colour of 5.2 was recorded in T_{12} (40 DF : 15 MP : 45 WF) in cookies prepared with palm jaggery. Results are in accordance with the findings of Hussain *et al*. (2006) reported in flax seed (*Linum usitatissimum*) flour cookies and in sweet potato (*Ipomoea batatas*) flour cookies by Singh *et al*. (2008). Similarly, scores for aroma shows that highest of 8.5 in T_7 (30 DF : 10 MP : 60 WF) and lowest score of 5.0 was recorded in T_{14} (100 DF : 0 MP : 0 WF) in cookies prepared with palm jaggery. Similar results were also reported in biscuits prepared with mushroom (*Pleurotussajor caju*) by Utpal kumar *et al*. (2015).The highest score for texture of 8.4 in T_1 (20 DF : 0 MP : 80 WF) and lowest score for texture of 5.7 was recorded in T_8 (30 DF : 15 MP : 55 WF) in cookies prepared with palm jaggery. Similar results were also reported in biscuits prepared with oat flour and cheese by Swapna and Jayarajrao (2014).

Scores for taste of 8.8 was highest in T_2 (20 DF : 5 MP : 75 WF) and lowest score for taste of 5.8 was recorded in T_4 (20 DF : 15 MP : 65 WF) in cookies prepared with palm jaggery. Similar results were also reported in baked products prepared with blending of germinated brown rice by Mounika *et al*. (2017). Overall acceptability score of 8.5 was highest in T_2 (20 DF : 5 MP : 75 WF) and lowest score of 4.5 was recorded in T_{14} (100 DF : 0 MP : 0 WF) in cookies prepared with palm jaggery. Similar results were also reported in cookies prepared with blends of yam flour and wheat flour by Apotiola and Fashakin (2013).

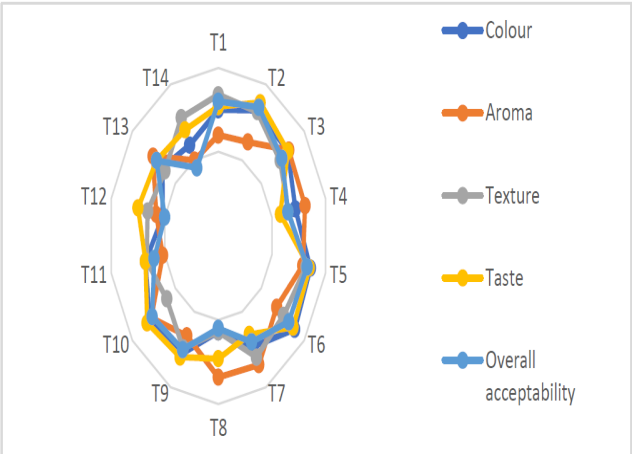

Fig. 2 : Sensory evaluation of cookies

Table 3 : Sensory evaluation scores of cookies prepared with palm jaggery

Treatments	Colour	Aroma	Texture	Taste	Overall acceptability
T1 - 20 (DF) : 0 (MP) : 80 (WF)	7.5	6.0	8.4	7.7	8.0
T2 - 20 (DF) : 5 (MP) : 75 (WF)	8.3	6.2	8.2	8.8	8.5
T3 - 20 (DF) :10 (MP) : 70(WF)	8.1	8.2	7.2	8.1	7.4
T4 - 20 (DF) :15 (MP) : 65(WF)	7.2	8.1	6.5	5.8	6.5
T5 - 30 (DF) : 0 (MP) : 70 (WF)	8.6	7.9	8.2	8.5	8.3
T6 - 30 (DF) : 5 (MP) : 65(WF)	8.9	6.8	7.6	8.7	8.2
T7 - 30 (DF):10 (MP) : 60(WF)	7.3	8.5	8.0	6.5	7.0
T8 - 30 (DF) :15 (MP) : 55(WF)	5.7	8.4	5.7	7.3	5.5
T9 - 40 (DF) : 0 (MP) : 60 (WF)	7.8	6.6	7.4	8.0	7.5
T10 - 40 (DF) : 5 (MP) : 55(WF)	8.0	7.8	6.0	8.3	7.7
T11 - 40 (DF) : 10 (MP) : 50 (WF)	6.8	5.2	6.7	6.8	6.0
T12 - 40 (DF) : 15 (MP) : 45 (WF)	5.2	5.8	6.6	7.5	5.0
T13 - 50 (DF) : 0 (MP) : 50 (WF)	6.5	7.6	6.2	7.2	7.2
T14 - 100 (DF) : 0 (MP) : 0 (WF) (control)	6.0	5.0	7.8	7.0	4.5
SE(m) ±	**0.147**	**0.142**	**0.144**	**0.152**	**0.141**
C.D at 5%	**0.208**	**0.431**	**0.438**	**0.463**	**0.428**

Conclusion

From the above mentioned results, it is concluded that the good quality and acceptable cookies are prepared with Dioscorea flour substituted from 10 per cent to 40 per cent with wheat flour and addition of moringa leaf powder up to 10 per cent is acceptable beyond that addition acceptability score for cookies decreases due to increase in the bitterness of cookies prepared with palm jaggery. By considering all the proximate composition data and sensory evaluation of the cookies the optimized treatment of T_2 (20 DF : 5 MP : 75 WF) is considered best among all the combinations.

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