e-ISSN 2320 –7876 www.ijfans.org
Vol.11, Iss.7, 2022
 UGC CARE Listed (Group -I) Journal

Original article

Development And Evaluation Of Millet Cookies Processed With Sorghum And Little Millet Incorporated With Palm Jaggery And Tamarind Kernel Powder

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Abstract

Millets are highly nutritious foods which contain complex carbohydrates, essential aminoacids, essential fatty acids and contains good amount of dietary fibre, Iron and Calcium which meets the requirements of a balanced diet of different age groups. Millets are also known as Nutri-cereals and render numerous health benefits to the consumers in reduction of non-communicable diseases like diabetes mellitus, thyroid and cardiovascular diseases. In spite of their multiple health benefits, millets are only consumed by people who are of low income group due to lack of awareness on their nutritional benefits, poor processing technologies and inconvenience in preparation of various food products as they require prior processing. The present study was done to develop and analyse the nutritional value, physiochemical properties and shelf life studies of millet cookies as readymade snack which is developed through standardization process by blending the major millet i.e Sorghum (*Sorghum bi*color) and minor millet i.e Little millet (Panicum sumatrense), Tamarind kernel powder (Tamarindus indica) , Wheat Flour and palm jaggery powder. Millet cookies that was highly accepted by thirty semi-trained panel members through nine point hedonic scale by formulating sorghum, little millet and other ingredients showed total carbohydrates, protein, fat and fibre about 57%,8%,25%2.6% respectively. The sensory evaluation of the acceptable cookie revealed that the texture, appearance ,color, aroma ,taste and all quality parameters were in acceptable range during storage . The shelf life of millet cookie was 90 days without any addition of preservatives when packed in polyethylene terphthalate tray that was placed in multilayer plastic laminate pouch at room temperature. The sensory parameters of millet cookies packed in polyethylene terphthalate tray declined without multilayer plastic laminate pouch .The work done was an attempt to develop value added products

of major and minor millets and increase consumption of millet products for better nutrition of consumers.

Key words: Sorghum, little millet,Wheat flour, tamarind kernel powder, palm jaggery powder, sensory evaluation, packaging materials, shelf life.

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Introduction

Millets are considered to be staple food of people living in Asia and Africa continents. The cultivation of millets throughout the world started before ten thousand years. Millets are known to contain major and micronutrients like carbohydrates, proteins, fats, vitamins and minerals. They provide nutritional security and contain good amount of complex carbohydrates which are considered to be the major sources of energy (Taylor et al 2006).Millets require less rainfall for cultivation and can survive extreme weather conditions. Investment to produce millet crops by farmers is comparatively less when compared to that of cultivation of staple food crops like Paddy and Wheat. Millets are classified as major cereals and minor cereals. Major millets are are sorghum and pearl millet and minor millets includes finger millet (*Eleusine coracana*), foxtail millet (*Setaria italica*), proso millet (*Panicum miliaceum*), barnyard millet (*Echinochloa spp*.), kodo millet (*Paspalum scrobiculatum*), and little millet (*Panicum sumatrense*). Each type of millet has more nutrient profile than rice and wheat. Finger millet has thirty times more calcium than rice while every other millet has at least twice the amount of calcium. Various studies conducted on major and minor millets revealed that the consumption of these coarse cereals can prevent lifestyle diseases. Millets contain many photochemicals (Sarita et al 2016) in the form of Dietary fibre, slow digestable carbohydrates, high protein content, Anti-oxidants, vitamins and minerals which are used in the management of non-communicable disease like Diabetes, Hypertension, obesity and cardio-vascular diseases. Out of major millets grown, Sorghum is considered to be the prominent crop which serves as food and considered to contain good nutrient profile than rice and wheat which can combat malnutrition globally. In terms of ranking in production of cereals throughout the world and in India, it accounts for fifth rank globally and stands in fourth place in India respectively. Sorghum is good source of essential vitamins and minerals like thiamine, folic acid,iron,calcium,phosphorus,zinc and sodium. Sorghum contains high amount of dietary fibre which plays a crucial role in reduction of cardiovascular diseases, diabetes milletus etc. Out of minor millets, little millet is considered to be most underutilised millet inspite of its wide

application in preparation of processed foods. The cultivation of little millet is increasing in India and Karnataka state occupies predominant place in terms of production. Little millet has good nutrient profile especially in terms of Dietary fibre.

Tamarind kernel powder which consists of carbohydrates, protein, fat and valuable amino acidsis widely used in food industries and roasted tamarind kernel powder is extensively used in preparation of processed foods(Bhattacharya et al 1990) and bakery products due to its excellent binding property. Palm Jaggery powder is excellent source of nutritive value that has high calcium content and can be used in processed foods as a replacer for refined sugar which raises the glycemic index of blood immediately due to its refined form. Due to Urbanisation, the demand for convenience foods is increasing (Rao et al2018).Millets are used for developing processed food products (Mohamad et al 2019).So, present work is done for developing ready to eat cookies made with major and minor millet i.e Sorghum and little millet to improve overall health of society by providing better immunity and solving malnutrition problem of society which is much commonly found in poor people (Godfray et al 2010). Cookies are ready to eat convenience snack food products which are good source of major and micro nutrients and can be used to feed infants and children of all age groups (Ferial & Azza,2011).Among snacks, cookies are considered to be most acceptable food due to their sensory properties(Sudha et al 2007). The demand for gluten free foods is increasing day by day. Recently, millets which are gluten free are processed in to nutritious healthy foods which are widely made of sorghum. These gluten free foods contain rich nutrient profile and chemical constituents (dietary fiber, proteins, fatty acids, minerals) and bioactive compounds (Brites et al., **2018**; Taylor et al., **2006**; Torbica et al. **2012**).

Materials and Methods

Procurement of Raw materials

Major and minor ingredients like Sorghum (*Sorghum bi*color), Little millet (Panicum sumatrense), Tamarind kernel powder (Tamarindus indica) , Cardamom (*Elettaria cardamomum*), Wheat Flour, Vanaspati, Butter, Ghee, palm jaggery, sodium bicarbonate polyethyelne teraphalate tray(250µ film thickness),Multilayer plastic laminate(84µfilm thickness) were procured from local market in Karimnagar,Telangana.

Processing

Sorghum and little millet procured were thoroughly cleaned to separate dust and any extraneous material present and millet grains were finely powdered and sieved (60 mesh size)

Formulation of millet cookies

Millet cookies was prepared by different variations using Wheat flour as control and millet flours(Sorghum and little millet in the ratio of 1:1) along with other ingredients like palm jaggery and tamarind kernel powder. Standardisation of millet cookie was done by using various proportions of wheat flour and millet flour(40:50,30:60,20:70,10:80,0:90). Tamarind kernel powder was used 10% in all the formulations.

Table 1 : Formualtion of Millet cookies for standardisation:

Sample No	Control Wheat flour(gms)	Millet flour 1:1 (gms) Sorghum Little millet	Tamarind kernel powder(gms)	Butter & Vanaspati 1:1 (gms)	Palm Jaggery (gms)	Coconut powder (gms)
Control	100	-	-	26.5	53 Refined sugar	-
1	50	40	10	50	50	5
2	40	50	10	50	50	5
3	30	60	10	50	50	5
4	20	70	10	50	50	5
5	10	80	10	50	50	5
6	-	90	10	50	50	5

Cookie preparation and evaluation

Cookies made of 100% wheat flour were prepared as per the method described by Tyagi et al(2007). The control cookies formula based on various proportions of ingredients are: 100 g wheat flour,53 g sugar,26.5 shortening,12 cm^3 water, sodium bicarbonate1.1 g and sodium chloride 0.89g. Dough was prepared by mixing major and minor ingredients and sheeted to a thickness of 1 cm and moulded in to round shape with a diameter of 5.5 cm. The moulded dough is kept in electric oven and baked at 180˚c for 15 minutes. After baking, cookies are cooled to room temperature. The baked cookies made of 100% wheat flour and millet flours of various proportions made using various proportions of major and minor ingredients are tightly packed in Polyethylene terephthalate tray and placed in Multilayer plastic laminate(84µm film thickness) for shelf life studies

Flow chart for preparation of millet cookies

Ingredients :

Sorghum flour,Little millet flour, wheat flour, tamarind kernel powder, Palm Jaggery, Butter, Vanaspathi, coconut powder, vanilla essence, skimmed milk powder, sodium bicarbonate, vanilla essence

Processing methods involved: Baking

Procurement of raw materials

⇩

Weigh all ingredients

⇩

Sieving of flours for removing foreign matter and uniformness of particle size

⇩

Mix butter and palm jaggery powder till creamy consistency

⇩

Add all the flours and other minor ingredients and make soft dough

⇩

Kneeding and Sheeting of dough(thickness of 1 cm)

⇩

Moulding of dough with biscuit cutter

⇩

Bake the dough in oven (180 degree Centigrade/15 min)

⇩

Cool millet cookies to room temperature

⇩

Pack cookies in **Polyethylene terephthalate tray**

and place it in Multilayer plastic laminate(84µm film thickness) for shelf life studies

Sensory evaluation

The developed millet cookies of various formulations was evaluated for various parameters viz color, flavour, texture, taste, appearance and overall acceptability through sensory evaluation by 30 semi-trained panel members on 9- point Hedonic scale rating test (Lim et al 2011) which measures the pleasurable and unpleasurable experiences of a particular food product on a scale ranging from 1-9 against the control sample to select best accepted millet cookies. The hedonic scale rating for different attributes is as follows 1.disike extremely 2.dislike very much 3.dislike moderately 4. Dislike slightly 5.neither like nor dislike 6.like slightly 7.like moderately 8.like very much 9.like extremely. The semi-trained panel members are selected from faculty and post graduate students in Dept of Food Technology, Satavhana university, Karimnagar depending on their individual interest and ability to evaluate food. Based on the sensory evaluation data given by sensory panel members, millet cookies that recorded highest sensory scores was finalised as most acceptable product and further evaluated for physic-chemical parameters and shelf life studies

Proximate analysis:

The accepted millet cookies was analysed for its proximate composition such as moisture(hot air oven method, AOAC2005),Total protein(micro-kjeldhal method AOAC 2005),fat(soxhlet method, AOAC2005),total dietary fibre(AOAC2005).Total and available carbohydrate content were calculated by difference method (100- moisture+protein+fat+ash+fiber). The total mineral content was measured by ashing method while calcium and iron content was estimated using titrimetric method and calorimetric method respectively. Energy (Kcal/100gm) was calculated for all the samples as (Carbohydrate gm x 4) + (Protein gm x 4)+ Fat gm x 9).

Physical characters of cookies

Vernier calliper is used to measure the thickness of cookies .Diameter of cookies was determined by edge to edge method using a scale. Spread ratio of cookies was determined by using the formula (W/T) where W represents diameter and T represents thickness. Physical parameter like bake loss is also measured by weighing five number of cookies i.e before and after baking. Bake loss is represented as difference in weight between the two measurements done before and after baking

Determination of colour of accepted millet cookies

The Color of the Millet cookies was measured using hunter lab color flex meter (Hunter Associates Laboratory Inc., Reston, Virgina,USA).Colour was measured in terms of **L*, a*** and **b*** values . **L*** is known as value of lightness and extends from 0 (black) to 100 (white).The value of **chroma a*** represents redness (+60) to greeness (-60). Similarly, value of **chroma b*** represents yellowness(+60) to blueness (-60)(Hutchings J.B 1999). Colour values of control cookies and accepted millet cookies were respectively recorded.

Texture profile analysis

The texture profile of the accepted millet cookies was analysed using the characteristics like hardness and fracturibility which are widely used in analysing the texture profile of foods(Paula et al 2014). Hardness is defined as the force used by the molar teeth to crush the food and fracturibilty is defined as breaking of food in to pieces by using incisors .The accepted Millet cookies was analysed for texture profile by using Texture analyser instrument(Model TA-XT plus,Stable Micro Systems, UK).Texture profile of cookies was carried out by Bourne method(1978) using p/75 probe. A load cell of 5 kg was used and the probe was allowed to compress the millet cookie. The following parameters like hardness and fracturability were recorded respectively which are very important in determining the texture profile of food products. The peak force was represented as fracture strength

Determination of Water activity

Water activity of millet cookie was determined at 25˚C (±0.2˚C) using a digital water activity meter (Aqualab water activity meter,USA). Water activity meter works on the principle of dew point. Water activity value ranges from 0 to 1 which determines the amount of free water available for the growth of micro-organisms. Cookies crumb about two grams was allowed to equilibrate within the headspace of sealed chamber. The reading is measured when the equilibrium is reached(Decagon,2007).Water activity is crucial in determining the shelf life of baked products.

Shelf life studies

The accepted millet cookies made with sorghum,little millet and palm jaggery as major ingredients is evaluated for its shelf life for a period of **three** months. Millet cookies was placed in Polyethylene terephthalate(PET) tray(250µm film thickness) as primary packaging material and PET tray containing millet cookies is further placed in multilayer plastic laminate(84µm film thickness that is made of three films such as 12µPET/12µMetallised PET/50µPolyEthylene with a GSM of 85g/sqm) pouch as a secondary packaging material and stored at room temperature to determine shelf life. The shelf life of millet cookies was compared with two packaging materials i.e

millet cookies placed in Polyethylene terephthalate tray and Multilayer plastic laminate used as outer wrapping for the Polyethylene terephthalate tray. Shelf life of millet cookies is also evaluated by placing millet cookie only in Polyethylene terephthalate tray without using Multilayer plastic laminate. Various microbial shelf life studies like bacteria, yeast and mould count, E.Coli were evaluated by standard plate count method using the standard procedures(IS:5402-2012),(IS:5887 part 1 1976) and (IS:5403:1999). The number of colony forming units were calculated and compared with standard permissible limits(FSSAI 2012). Periodically at an interval of 15 days, overall acceptability and shelf life of millet cookies was assessed through sensory evaluation and microbial analysis.

Statistical analysis

The statistical significance of data obtained was analysed by one way analysis of variance i.e ANOVA. The data is subjected to descriptive statistics such as mean and standard deviation of sensory evaluation scores and other parameters during shelf life studies. Statistcal tests are performed between various treatments to know the P value i.e the probability value. The mean differences between treatments were calculated using the Critical difference value ($P \leq 0.05$& $P \leq 0.01$) to determine whether the samples are significant or not significant

Results and Discussion

Sensory evaluation and statistical analysis

Table: 2

Sample	**Mean scores of samples (9-point hedonic rating scale)**					
	color	***flavour***	***texture***	***taste***	***appearence***	**overall acceptability**
Control	7.46	7.43	7.66	7.4	7.46	7.53
S1	8.2	7.9	8.13	7.9	8.26	8.13
S2	7.1	7.03	7.1	7.16	7.1	7.16
S3	7.06	6.83	6.93	7.03	6.8	6.96
S4	7	6.43	6.66	6.7	6.5	6.66
S5	6.86	6.56	6.53	6.73	6.63	6.63
S6	6.53	6.3	6.33	6.4	6.36	6.33

Best accepted sample is **S1.**Sample -1 which has shown highest mean score for all the sensory attributes.

S1: sample no: 1; S2 sample no: 2; S3:Sampleno: 3; S4: sampleno:4; S5 sampleno:5

Critical values of F for the 0.05 significance level from 'F' distribution table: =2.43

- Critical values of 'F' X Standard Error = 2.43 X 0.106096= 0.25781328
- Upper Limit: Mean of control + (Critical values of 'F' for the 0.01 X Standard Error)= 7.53+0.25781328=7.78781328
- Lower Limit: Mean of control - (Critical values of 'F' for the 0.01 X Standard Error) =
- 7.53-0.25781328=7.27218672

Table 2.1

	MEAN (Overall acceptability)	**UPPER LIMIT**	**LOWER LIMIT**
Control	7.53	7.78781328	7.27218672
S1	8.13	Superior or significant	
S2	7.16	Inferior or not significant	
S3	6.96	Inferior or not significant	
S4	6.66	Inferior or not significant	
S5	6.63	Inferior or not significant	
S6	6.33	Inferior or not significant	

Critical values of 'F' for the 0.01 significance level from 'F' distribution table: = 3.50

- Critical values of 'F' **X** Standard Error = 3.50 X 0.106096= 0.371336
- Upper Limit: Mean of control + (Critical values of 'F' for the 0.01 **X** Standard Error)= 7.53+0.371336=7.901336
- Lower Limit: Mean of control - (Critical values of 'F' for the 0.01 **X** Standard Error) = 7.53-0.371336=7.158664

Table 2.2

	MEAN (Overall acceptability)	**UPPER LIMIT**	**LOWER LIMIT**
Control	7.53	7.901336	7.158664
S1	8.13	Superior or significant	
S2	7.16	Superior or not significant	
S3	6.96	Inferior or not significant	

S4	6.66	Inferior or not significant
S5	6.63	Inferior or not significant
S6	6.33	Inferior or not significant

The sensory evaluation data of millet cookies shown in table 1 revealed that addition of millet flours showed highest mean scores in the range of 6-9 (liked slightly – liked extremely) Later, increase in addition of Millet flours led to decrease of mean scores and no signifiacant Difference ($p>0.05$) was observed in overall acceptability amongst all cookies and thus sample one with forty percent millet flour that received highest mean scores for various sensory attributes was selected as best acceptable product and found to be superior or signicant based on Critical values of F(table 2.1 &2.2) for the 0.01 & 0.05 significance level from 'F' distribution table

Physico-chemical characteristics of millet cookies:

Millet cookies made of wheat flour and millet flour(Sorghum and little millet 1:1 ratio) in the proportion of (50:40) was evaluated for various physico-chemical characteristics like macro and micro nutrient analysis, colour , water activity, microbial studies and texture analysis. Various physico-chemical characteristics of millet cookies are as follows. Accepted Millet cookies was analysed for various physic-chemical characteristics

Table: 3 Nutrient composition of control and accepted millet cookies:

S.No	Nutrient Parameters	Control cookies (%Per 100gm)	accepted millet cookies (%Per 100gm)
1	Moisture content	3.34±0.06	5.07±0.13
2	Protein	7.30±0.1	8.08±0.12
3	Fat	20.9±0.32	25.57±0.66
4	Dietary fibre	1.30±0.03	2.6±0.2
5	Total carbohydrates	66.63±0.08	57.99±1.0
6	Ash	0.53±0.005	0.69±0.04
7	Calcium (mg/100 gm)	90.39±1.16	228.8±1.15
8	Iron (mg/100 gm)	2.54±0.01	1.64±0.05
9	Magnesium (mg/100 gm)	44.18±1.04	65.43±0.98
10	Potassium (mg/100 gm)	89.46±0.10	419±0.64
11	Energy(kcal)	462.94	494.41

Table: 4 Color analysis of control (100% wheat flour) and accepted millet cookies

Color	L *	a *	b *
Control cookies	63.09±0.21	6.31±0.12	26.17±0.14

(100% wheat flour)			
Accepted millet cookies	45.71±0.24	9.49±0.16	19.19±0.07

Table: 5 Water activity

S.no	**Parameter analysed**	**aW value for control cookies (100% wheat flour)**	**aW value for accepted millet cookies**
1	Water activity	0.35	0.46

Table: 6 Texture Analysis of Millet cookies :

S.No	**Parameter Analyzed**	**control cookies 100% wheat flour**	**accepted millet cookies**
1	Hardness (gm) Force-1	145.09	79.97
2	Fracturability(mm) Distance-1	1.22	1.31

Table 7 Physical analysis of 100% wheat flour cookies and accepted millet cookies

Samples	**Weight(g)**	**Thickness(mm)**	**Diameter(mm)**	**Spread ratio**	**Bake loss (g/100 g)**
Control	13.12± 0.10	8.77±0.40	50.10±0.03	5.72±0.07	17.78±0.21
Accepted millet cookies	14.15±0.19	8.99±0.11	51.92±0.19	6.28±0.05	14.25±0.19

Proximate composition of cookies:

Proximate analysis of cookies made from 100% wheat flour and accepted millet cookies (table 3) made of forty percent millet flours and ten percent tamarind kernel powder showed a significant difference in nutritive value of major and micro nutrients. The moisture content of control cookies and millet cookies ranged from 3.34% to 5.07% respectively. The difference in moisture is due to the addition of palm jaggery powder and increase in protein content. Mustafa et al (1986) reported that there is correlation in increase in moisture content to increase in protein content of bakery products. There was no much difference in protein content of control cookies and accepted millet cookies which were reported as 7.30% &8.08% respectively. The minor increase in protein content is due to addition of tamarind kernel powder which is a good source of protein. Fat content between

control and millet cookies has shown a 5% significant difference between two due to addition of butter and vanaspathi in accepted millet cookies which are good sources of fat. Dietary fibre content of millet cookies is found to be high i.e 2.6% when compared to that of control cookies i.e 1.30% due to high amount of fibre present in millets when compared to that of wheat flour that is devoid of fibre. The ash content which represents the inorganic matter i.e minerals is found to be high in millet cookies than that of control cookies. The major minerals like calcium,potassium are found to be high in millet cookies i.e about 228.8mg/100gms & 419 mg/100 gms as palm jiggery is good source of potassium and tamarind kernel powder is good source of calcium.

Color analysis:

From results in the (table 4), it was found that lightness of millet cookies (L*) showed a decreasing trend when compared to that control which indicates that millet cookies are darker in colour. On the other hand, it was found that values of millet cookies for redness a*increased and b* decreased when compared to that of control cookies. This may due to the non-enzymatic reactions that takes place during baking i.e maillard browning. During Baking, color change takes place i.eNon enzymatic reactions like Maillard browning and caramelisation occur due to interaction of reducing sugar of carbohydrates and amino group of proteins are known to produce brown color pigments known as melanoidins (Laguna et al 2011).These reactions are influenced by many internal and external factors surrounding the product such as heat, water activity, type of sugars and type of amino acids(Sharma and Gujral 2013; Stojceska et al 2009). Color of cookies is an important physical attribute or parmeter in acceptability of product by the consumer.

Water activity

Water activity results shown in the table 5 reveals that the millet cookies contain high amount of water activity than that of control cookies which are recorded as 0.35 & 0.46 respectively. The increase in water activity of millet cookies is due to presence of high moisture than that of control cookies. According to Cauvain and Young(2000), in a given product, the water activity increases with the availability of free water in the product which is available for the growth of micro-organisms. The results pertaining to water activity depicts that the control cookies and millet cookies are not susceptible to microbial attack as various enzymatic,chemical and microbial reactions are retarded below an aW level of 0.7.

Texture profile analysis

Hardness of millet incorporated cookies was least hard when compared to that of control cookies which reported to have an hardness of 145.08 g & 79.97 g respectively (table 6). The force required to break the millet cookies was less than that of control cookies. As per the reports given by Adebowale et al (2012) for cookies produced from sorghum wheat blends as well as wheat oat flour blends(Chavan & Kadam 1993) showed decrease in hardness respectively. The decrease in hardness with addition of millet flours substitution in cookies may be due to changes in protein content.

Physical properties of cookies

Physical parameters like (weight, thickness,diameter,spread ratio,bake loss) of control and millet cookies are shown in table 7. From the table, it is observed that the weight, thickness, diameter, spread ratio of millet cookies showed an increasing trend due to addition of millet flours, tamarind kernel powder and palm jaggery powder. Millet flours have low viscosity i.e resistance to flow when compared to that of wheat flour. Cookies made from low viscosity spreads quickly than that of cookies made of high viscosity dough (Hosney & Rogers 1994). Cookies having good spread ratio are highly desirable (Finney, Morris & Yamazaki 1950). Singh, Sharma and Saxena(2003) reported that increase in protein content led to increase in spread ratio. Bake loss of millet cookies decreased when compared to that of control cookies.

Storage studies (shelf life) of millet cookies:

Table: 8 Sensory parameters of millet cookies obtained by means of hedonic scale (nine point scale) during storage packed in Polyethylene terephthalate tray

Attributes	Initial 0^{th} day	15 days of storage	30 Days of storage	45 Days of storage	60 Days of storage	75 Days of storage	90 Days of storage	Mean
Color	**8.2**	8.0	7.8	7.7	7.4	7.0	6.9	7.57
Flavor	**7.19**	7.10	7.0	6.4	6.2	6.0	5.8	6.52
Texture	**8.13**	8.0	7.4	7.2	7.0	6.9	6.5	7.4
Taste	**7.9**	7.7	7.2	7.1	7.0	6.8	6.6	7.18
Appearence	**8.26**	8.1	7.9	7.7	7.5	7.4	7.2	7.72

Overall acceptability	**8.13**	8.0	8.0	7.3	7.1	7.0	6.9	7.49

Table 9: Sensory parameters of millet cookies obtained by means of hedonic scale (nine point scale) during storage packed in Polyethylene terephthalate tray and Multilayer plastic laminate

Attributes	**Initial 0th day**	**15 days of storage**	**30 Days of storage**	**45 Days of storage**	**60 Days of storage**	**75 Days of storage**	**90 Days of storage**	**Mean**
Color	**8.2**	8.1	8.0	7.8	7.6	7.3	7.2	7.74
Flavor	**7.19**	7.10	7.0	6.8	6.5	6.4	6.3	6.7
Texture	**8.13**	8.1	7.7	7.7	7.6	7.5	7.4	7.73
Taste	**7.9**	7.7	7.4	7.3	7.3	7.2	7.2	7.42
Appearence	**8.26**	8.24	8.1	8.0	8.0	8.0	8.0	8.08
Overall acceptability	**8.13**	8.1	8.0	7.5	7.2	7.0	7.0	7.56

Based on the above data(Table 8 & 9), the millet cookies evaluated for its attributes packed in Polyethylene terephthalate tray during storage from initial day to 90th day revealed that the mean attributes scores are lower when compared to that of millet cookie packed in Polyethylene terephthalate tray and Multilayer plastic laminate. Due to better shelf life properties in millet cookie packed in Polyethylene terephthalate tray and Multilayer plastic laminate, further microbial studies were carried out by packing millet cookies in Polyethylene terephthalate tray and Multilayer plastic laminate..

Microbial evaluation (storage studies) of millet cookie to determine shelf life

Table: 10

Shelf life of cookies packed in Polyethylene terephthalate tray and Multilayer plastic laminate

(Total colonies of first two dilutions taken in duplicates i.e 10^{-2}&10^{-3})

S.No	**Microbial test (serial diliution @10^{-2})**	**Intial 0th day**	15th day	30thday	45th day	60th day	75th day	90th day
1	Total	Not detected	Not detected	Not detected	2	7	12	22

	plate count cfu/gm	(N.D)	(N.D)	(N.D)				
2	Yeast and mold count cfu/gm	Not detected (N.D)	Not detected (N.D)	Not detected (N.D)	4	8	15	27
3	E.coli cfu/gm	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT	ABSENT

From the above data shown in **table 9** i.e millet cookies packed in Polyethylene terephthalate tray and Multilayer plastic laminate revealed that millet cookie is stable without any presence of E.coli and yeast and moulds. In the first thirty days period of storage, millet cookies evaluated for various microbial tests did not show any colonies. After one month of storage period, a very few colonies (cfu/gm) were found or recorded to be negligible and can be treated as safe for consumption. As the storage period increased up to three months, a very less number of colonies are found which does not affect the quality and safety of cookies. The millet cookies is table up to 90 days and can be consumed up to 90 days when stored in Polyethylene terephthalate tray and Multilayer plastic laminate at ambient temperature.

Conclusion

The study revealed that best accepted millet cookies are good source of major and micro nutrients which are superior when compared to that of cookies made of wheat flour. The study provided the scope for utilization of major and minor millets and tamarind kernel powder for preparation of bakery products. It can be concluded that composite flours can be used through standardization process in preparation of bakery products. Cookies made of millet flours can be used as snack food for all age groups.

References

1. Taylor, J. R., Schober, T. J., & Bean, S. R. (2006). Novel food and non-food uses for sorghum and millets. *Journal of Cereal Science*, **44**(3), 252– 271.
2. Sarita, Ekta Singh (2016),Potential of Millets: Nutrients Composition and Health Benefits, Journal of Scientific and Innovative Research 5(2): 46-50

3. Bhattacharya, S. (1990). A study on the processing and utilization of tamarind *(Tamarindus indica)* kernel for food uses. PhD thesis, Post Harvest Technol- ogy centre, Indian Institute of Technology, Kharagpur. India.
4. Rao, B. D., Kulkarni, D. B., & C., K. (2018). Study on evaluation of starch, dietary fiber and mineral composition of cookies developed from 12 sorghum cultivars. *Food Chemistry*, **238**, 82– 86.
5. Godfray, H.C.J.; Beddington, J.R.; Crute, I.R.; Haddad, L.; Lawrence, D.; Muir, J.F.; Pretty, J.; Robinson, S.; Thomas, S.M.; Toulmin, C.(2010), Food security: The challenge of feeding 9 billion people. Science 327, 812–818.
6. Mohamed, A. I. A., Al-Juhaimi, F. Y., & Bekhit, A. E. D. A. (2019). Fermentation of grains. In L. Melton, F. Shahidi & P Varelis (Eds), *Encyclopedia of Food Chemistry*, Vol. **2**, (pp. 107– 116). Oxford: Academic Press.
7. Sudha, M. L., Vetrimani, R., Leelavathi, K. (2007). Influence of fibre from different cereals on the rheological characteristics of wheat flour dough and on biscuit quality. *Food Chemistry*, **100**(4), 1365– 1370
8. Brites L. T.G, Ortolan F., Silva D. W., Bueno F. R., Rocha T. de S., Chang Y. K., Steel C. J. (2019). Gluten-free cookies elaborated with buckwheat flour, millet flour and chia seeds. *Food Science and Technology*, **39**(2), 458– 466.
9. Tyagi SK, Manikantan MR, Oberoi HS, Kaur G (2007) Effect of mustard flour incorporation on nutritional, textural, and organoleptic charac- teristics of biscuits. J Food Eng 80(4):1043–1050
10. Lim, Juyun. (2011). Hedonic scaling: A review of methods and theory. Food Quality and Preference -food qual preference. 22. 733-747. 10.1016/j.foodqual.2011.05.008.
11. AOAC(2005),Official method of analysis(18th edition), Association of Official Analytical Chemists,Washington DC
12. (pp. 107– 116). Oxford: Academic Press.
13. Paula, A. M., & Conti-Silva, A. C. (2014). Texture profile and correlation between sensory and instrumental analyses on extruded snacks. *Journal of Food Engineering*, *121*, 9-14.
14. FSSAI (2012) Manuals of methods of analysis of foods, microbio- logical testing. Food safety and standards authority of India. Ministry of Health and Family Welfare, Government of india, new delhi
15. Mustafa AI,Alwessali MS, SI Bhusha OM,Al Amia RH(1986), Utilisation of cow pea flour and protein isolate in bakery products, Cereal food world 31:756-759

16. Laguna L, Salvador A, Sanz T, Fiszman SM (2011) Performance of a resistant starch rich ingredient in the baking and eating quality of short-dough biscuits. LWT Food Sci Technol 44:737–746
17. Sharma P, Gujral HS (2013) Extrusion of hulled barley affecting b-glucan and properties of extrudates. Food Bioprocess Technol 6:1374–1389
18. Adebowale, A.A,Adegoke,M.T Sanni,S,A,Adegunwa(2012).Functional properties of biscuit making potentials of sorghum wheat flour composite.American journal of food technology,7,372-379
19. Chavan,J.K & Kadam,S.S(1993). Nutritional enrichment of bakery products by supplementation with non wheat flours. Critical reviews in food science & Nutrition, 33,189-226.