Process Optimization, Sensory and Physicochemical properties of Gluten Free Cookies

P. S. Mahajan*, A. K. Sahoo and S. M. Lokhande

Department of Technology, Shivaji University, Kolhapur – 416004, India.

Abstract:

Cookie is a small, flat, sweet, baked food usually contains flour, sugar and either butter or hydrogenated vegetable fat. In this experimental work gluten free cookies are prepared by replacing refined wheat flour with sorghum, pearl millet and ragi flour at proportions (50:40:10) (50:30:20) (50:20:30) and (50:10:40) respectively. Those flours were roasted for 5 minutes. Soya lecithin was used as emulsifier and optimize at proportion of 0.5%, 1.0%, 1.5%. The roasted flours, baking powder, soya lecithin were mixed with creamed sugar with fat, milk and dough is prepared. After sheeting, cookies are baked in preheated oven at 180°c for 30 minutes. The combinations of these flours at different proportions along with hydrogenated fat are subjected to sensory evaluation for optimizing the best formulation for preparation of gluten free cookies. The proportion of flours (sorghum, pearl millet, finger millet) 50:20:30 was selected with 0.5% S. lecithin. This gluten free cookies contains moisture 2.98%, carbohydrate 68%, protein 10.10%, ash 1.02%, fat 17.6% and total energy 471.92 kcal. The gluten free cookies having highest hedonic score is analysed for Physico-chemical parameters. These gluten free cookies will be consumed by gluten allergic i.e. celiac disease people. These cookies are rich in protein, fibre and minerals especially iron.

Keywords: Gluten free, Fibre, Protein, Celiac, Cookies

1. Introduction

Cookies are widely consumed bakery products due to their long shelf life and strong consumer preference. Although the structure forming ability of gluten influences the rheological properties of dough and affects overall appearance of bakery products, the development of gluten network in biscuit and cookie dough is minimal and undesirable. Therefore, the efforts in gluten free cookie production are more frequently related to the fortification of gluten free formulations to achieve better nutritional profile of biscuits and cookies with acceptable sensory properties.

Sorghum (*sorghum bicolor*) is a genus of grasses with about 30 species, one which is raised for grain and many of which are used as coder plant, either cultivated or as part of pasture. It is rich in vitamin and minerals and has many health benefits. It is gluten free. Sorghum is processed into a variety of traditional foods including fermented and non-fermented products such as unleavened bread, porridges, cookies, cakes, cereal extracts and malted alcoholic and non-alcoholic beverages. Cereal malt may also be incorporated as amylase source to infant flour to reduced viscosity of starchy porridges and allow their preparation at high concentration, and thus high energy density (Ferreira *et al.*, 2015).

Pearl Millet [*Pennisetum americanum (L.) Leeke*] is an important cereal, contributing to the calorie and protein requirements of people in the semi-arid tropics (SAT). Several food preparations are made from pearl millet, in Africa and India. Roti or chapatti unleavened flat bread, is the most common product made from pearl millet in India. Information on the food quality attributes of this product and on the physical and chemical characteristics of pearl millet is rather limited. Studies on wheat and rice have led to the identification of grain components such as, proteins, pentosans, amylose, lipids and ash as important characteristics that influence the quality of food products. (Subramanian. *et al*., 1986).

Finger millet (Ragi, *Eleusine Coracana*) is an important staple food in the central Africa as well as some parts of India (Majumder *et al.*, 2006). It is rich in protein, iron, calcium, phosphorus, fibre and vitamin content. The calcium content is higher than all cereals and iodine content is said to be highest among all the food grains. Ragi has best quality protein along with the presence of essential amino acids, vitamin A, vitamin B and phosphorus (Gopalan *et al*., 2004). Thus, ragi is a good

source of diet for growing children, expecting women's, old age people and patients. Ragi provides highest level of calcium, antioxidants properties, phytochemicals, which makes it easily and slowly digestible. Hence it helps to control blood glucose levels in diabetic patients very efficiently. The bulkiness of the fibers and the slower digestion rate makes us feel fuller on, fewer calories and therefore may help to prevent us from eating excess calories. (Kang *et al.*, 2008; Lakshmi *et al*., 2002).

These cookies are prepared by using sorghum, pearl millet, finger millet flour which are completely gluten free. Even these cookies are very cheaper to produce commercially. These cookies are rich in protein and minerals. These cookies are good source of nutrition for celiac disease people and normal people too.

2. Materials

2.1 Raw materials

Commercial Sorghum flour, Pearl millet flour and finger millet flour was purchased from local market. Those flours were milled in roller mills and sieved to obtain a particle size 100µm. All the flours were roasted at 100°c for 5 minutes. Proportion of flours is as shown in Table no.1.Hydrogenated fat (dalda), full cream milk, baking powder, cane sugar, soya lecithin was taken from local market with superior quality.

2.2 Equipments

Glass utensils such as burette, pipette, test tubes, petri plate set and other utensils such as stainless-steel pots, plates, knives and convection bakery oven were available in the laboratory.

3. Methods

3.1 Preparation of Cookies:

Cookies will be prepared as per following method with slight modification (Dhankar, 2013).

Weighing of Ingredients

↓

Creaming

↓

Roasting of all flours

(sorghum, pearl millet, Finger millet, spent grain)

↓

Mixing Sheeting

↓

Cutting

↓

Baking

(180 °C for 25 Minutes)

↓

Cooling

↓

Weighing and Packing

Fig. 1: Flow sheet for Preparation of Cookies

3.2 Flour and Emulsifier optimization

Table 1: Formulation of cookies by optimization sorghum, pearl millet flour proportions

Sample	Sorghum	Pearl millet
T1	100	0
T2	90	10
T3	80	20
T4	70	30
T5	60	40
T6	**50**	**50**
T7	40	60
T8	30	70
T9	20	80
T10	10	90
T11	0	100

The T1, T2, T3, T4, T5, T6, T7, T8, T9, T10, T11 samples were prepared by replacing refined wheat flour. All were prepared by using sorghum, pearl millet & finger millet flour respectively. Cookies were having cracks at edges. In between those sample T6 (sorghum: pearl millet = 50:50) was selected as best as per the 9 point hedonic scale sensory evaluation.

Table 2: Formulation of cookies by optimization of sorghum, pearl millet and finger millet flour proportions

Sample	Sorghum	Pearl millet	Finger millet
T12	50	50	0
T13	50	40	10
T14	50	30	20
T15	**50**	**20**	**30**
T16	50	10	40
T17	50	0	50

The T12, T13, T14, T15, T15, T16, T7, samples were prepared by replacing sorghum flour. is optimize in this trial at different proportions with pearl millet at different proportions. T4 having highest hedonic score which contain 50% sorghum, 25% pearl millet, 25% finger millet flour. There are still small cracks at the edges.

Table 3: Formulation of cookies by optimization of soya lecithin in gluten free cookies

Sr no	Sample	Flour (gm)	Soya lecithin(gm)
T18	S flour :P flour: F flour	50:25:25	0
T19	S flour :P flour: F flour	50:25:25	0.5
T20	S flour :P flour: F flour	50:25:25	1.0
T21	S flour :P flour: F flour	50:25:25	1.5

The gluten free cookies sample selected in last trial with sorghum, pearl millet, finger millet percentage of 50, 25and 25 respectively. Soya lecithin is used as emulsifier in different product Here soya lecithin was optimise at different level. In which T2 sample having more hedonic score as well as the perfect crispiness.

3.3 Cookie preparation

All cookies were prepared using the same amount of ingredients except for water, which was added to adjust dough moisture content to 15.0%. The following ingredients (as g/100 g on dough basis) were used: flour (46.29 g/100 g), sugar (23.14g/100 g), hydrogenated fat (g/ 100 g), milk (5.2 g/100 g), soya lecithin (0.23g/100gm) and sodium bicarbonate (0.9 g/ 100 g). The hydrogenated fat and sugar were then creamed manually with the hands, scraping down every 60 s. The milk was then added and mixing was continued with intermediate scraping. At the end of the mixing process, the cream was scraped down. Finally, flour and sodium bicarbonate were added, followed by mixing scraping down every 30 s. Cookie dough was cut with a circular cookie cutter (internal diameter, 40 mm) and weighed. Batches of at least 15 dough pieces were baked in an electric convection oven for 30 min at 180 °C. All the cookie elaborations were performed twice. The cookies were packaged in polyethylene bags and finally stored at 20 °C until further analyses.

4. Analytical Work:

4.1 Cookie Physico-chemical analysis*:*

Table No 4: Physico-chemical analysis of gluten free cookies

Nutrient	Amount (%)
Carbohydrates	68.28
Fat	17.60
Protein	10.10
Moisture	2.98
Ash	1.02
Minerals (mg)	
Iron	301.9
Potassium	34.4
Zinc	17.15

Table No 5. Physical properties of Gluten free cookies

Properties	Gluten free Cookies
Thickness (mm)	8.7
Diameter (mm)	40.52
Volume (cm^3)	788.4
Spread ratio	9.38

The gluten free cookies having highest hedonic score is analysed for Physico-chemical parameters. These gluten free cookies will be consumed by gluten allergic i.e. celiac disease people. These cookies are rich in protein, fibre and minerals especially iron.

5. Results and discussion:

5.1 Sensory evolution

Hedonic sensory evaluation of the cookies was conducted with 10 volunteers, who were habitual cookie consumers. Samples were analyzed one day after baking. For sensory evaluation, samples were presented on dishes coded with alphabetical order and served in random order. The cookies and cakes were evaluated on the basis of the acceptability of their appearance, odour, texture, taste and overall acceptability on a nine-point hedonic scale. The scale of values ranged from ‘‘extremely like’’ to ‘‘extremely dislike’’, corresponding to the highest and lowest scores of ‘‘9’’ and ‘‘1’’ respectively. Cookies were presented as whole pieces.

Table No 6: Sensory Evaluation of cookies by optimization of sorghum, pearl millet flour proportions

Sample code	Appearance	Taste	Flavour	Texture	Overall acceptability
T1	6	5.5	5.8	5.5	5.5
T2	6.1	5.8	6	6.1	6
T3	6.2	6	6.2	6.2	6.2
T4	6.4	6.1	6.3	6.4	6.2
T5	6.8	6.2	6.4	6.3	6.5
T6	**7.2**	**7.5**	**7**	**7.2**	**7.5**
T7	6.8	6.7	6.8	6.7	6.8
T8	6.6	6.5	6.4	6.3	6.5
T9	6.4	6.4	6.2	6.4	6.2
T10	6.3	6.3	6	6.3	6.1
T11	5	6.2	5.5	6.2	5.9

The T1, T2, T3, T4, T5, T6, T7, T8, T9, T10, T11 samples were prepared by replacing refined wheat flour. All were prepared by using sorghum, pearl millet & finger millet flour respectively. Cookies were having cracks at edges. In between those sample T6 (sorghum: pearl millet = 50:50) was selected as best as per the 9 point hedonic scale sensory evaluation.

Table No 7: Sensory Evaluation of cookies by optimization of sorghum, pearl millet and finger millet flour proportions

Sample code	Appearance	Taste	Flavour	Texture	Overall acceptability
T12	7.2	7.0	7.1	7.3	7.1
T13	6.3	6.2	6.4	6.3	6.5
T14	6.8	6.4	6.6	6.8	6.6
T15	**7.3**	**7.5**	**7**	**7**	**7.5**
T16	6.7	6.8	6.3	6.8	6.8
T17	6.5	6.7	6.5	6.5	6.5

The T12, T13, T14, T15, T16, T17 samples were prepared by replacing sorghum flour. is optimize in this trial at different proportions with pearl millet at different proportions. T4 having highest hedonic score which contain 50% sorghum, 25% pearl millet, 25% finger millet flour. There are still small cracks at the edges.

Table No 8: Sensory Evaluation of cookies by optimization of soya lecithin in gluten free cookies

Sample code	Appearance	Taste	Flavour	Texture	Overall acceptability
T18	7.3	7.5	7	7	7.5
T19	8.5	8	8.5	8.5	8.5
T20	7.5	7.5	7.8	7.8	7.7
T21	7.3	7.5	7.6	7.5	7.5

The gluten free cookies sample selected in last trial with sorghum, pearl millet, finger millet percentage of 50, 20 and 30respectively. Soya lecithin is used as emulsifier in different product. Here soya lecithin was optimized at different level. In which T19 sample having more hedonic score as well as the perfect crispiness.

6. Conclusion

Gluten free cookies were prepared by replacing refined wheat flour with sorghum, pearl millet and ragi flour Cookies made from sorghum, pearl millet, finger millet flour at proportions (50:40:10) (50:30:20) (50:20:30) and (50:10:40) respectively. Those flours were roasted for 5 minutes. Soya lecithin was used as emulsifier and optimize at proportion of 0.5%, 1.0%, 1.5%. The roasted flours, baking powder, soya lecithin was mixed with creamed sugar with fat, milk and dough is prepared. After sheeting, cookies are baked in preheated oven at 180°c for 30 minutes. The proportion of flours (sorghum, pearl millet, finger millet) 50:20:30 was selected with 0.5% S. lecithin. The effect of addition of spent grain in gluten free cookies were studied with respective to its physical characteristics and organoleptic characteristics. Gluten free cookies were stored in LDPE (Low Density Polyethylene). Cookies made from sorghum, pearl millet, finger millet flour did not spread during baking, had poor top grain character, and were dense and compact. In addition, they were mealy and gritty without roasting of flours. Roasting improves baking quality of cookie. The use of soya lecithin (0.5%) improved top grain even more than did wheat lipids. The texture of cookies containing part of pearl millet and finger millet was much better.

7. Reference

- Anglani, C. (1998). Sorghum for human food–A review. *Plant Foods for Human Nutrition*, *52*(1),85-95.
- A.O.A.C. 2000. Official Methods of Analysis. Association of Official Analytical Chemists, Washington, D. C.USA. 17th Edition.
- Corke, H., De Leyn, I., Nip, W. K., & Cross, N. A. (2008). *Bakery products: science and technology*. John Wiley & Sons.
- Dhankhar, P., & Tech, M. (2013). A study on development of coconutbased gluten free cookies. *International Journal of Engineering Science Invention*, 2(12), 10-19.
- Edwards W.P.,(2007) textbook of The Science of Bakery Products.
- Engleson, J., & Atwell, B. (2008). Gluten-free product development. *Cereal Foods World*, *53*(4), 180-185.

- Ferreira, S. M. R., de Mello, A. P., dos Anjos, M. D. C. R., Krüger, C. C. H., Azoubel, P. M., & de Oliveira Alves, M. A. (2016). Utilization of sorghum, rice, corn flours with potato starch for the preparation of gluten-free pasta. *Food chemistry*, *191*, 147-151

- Gambus, H., Gambus, F., Pastuszka, D., Wrona, P., Ziobro, R., Sabat, R., & Sikora, M. (2009). Quality of gluten-free supplemented cakes and biscuits. *International journal of food sciences and nutrition*, *60*(4), 31-50.

- Kaur, M., Sandhu, K. S., Arora, A., & Sharma, A. (2015). Gluten free biscuits prepared from buckwheat flour by incorporation of various gums: physicochemical and sensory properties. *LWT-Food Science and Technology*, *62*(1), 628-632.

- Lai, H. M., & Lin, T. C. (2006). Bakery products: science and technology. *Bakery products:*
- *Science and technology*, 3-65
- Steinfurth, D., Koehler, P., Seling, S., & Mühling, K. H. (2012). Comparison of baking tests using wholemeal and white wheat flour. *European Food Research and Technology*, *234*(5), 845

- Tanwar, B. and Dhillon, M. (2017). Preparation and nutritional quality evaluation of gluten free cookies,*Asian Journal of Dairy And Food Research*, 36 (1): 63-66.

- Rao, B. D., Anis, M., Kalpana, K., Sunooj, K. V., Patil, J. V., & Ganesh, T. (2016). Influence of milling methods and particle size on hydration properties of sorghum flour and quality of sorghum biscuits. *LWT-Food science and Technology*, *67*, 8-13. 851.