Product Development and Quality Assessment of Pearl Millet based High Calorie Biscuit

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Abstract -A high-calorie food gives more energy and extra nutrition for human to heal from ailments. These foods can be used to supply adequate nutrition for athletes and calamity victims who faced disaster situations and are not accessible for food. Hence, the objective of this study was to develop a high energy biscuit using locally available raw materials to use as an emergency food. The biscuit was developed using pearl millet flour, pearl millet grits, corn flour, wheat flour and other basic ingredients used for biscuits. The biscuit was evaluated for proximate composition; chemical, physical, sensory characteristics and the calorific value. Biscuit contained 447 kcal/ 100 (High calorie, Energy > 300 kcal/kg) with a net weight of 5g each. Analysis of proximate composition resulted moisture;3.63±0.1% , ash;2.47±0.8% , fat;16.88±0.1%, protein;6.54±1.6%, fiber;0.98±0.9 % , dietary fiber ;3.51±0.03% and available carbohydrate; 67.39±0.1%. An accelerated shelf life was carried out for 12 weeks, storing the High calorie biscuit under four different temperatures (28°C±2, 37°C±2, 42°C±2, 50°C±2). Moisture content was significantly increased ($p<0.05$) and the free fatty acid content was not significantly ($p>0.05$) increased during the shelf life period of six months. Microbial counts, total plate count, coliform, yeast and mold were not detected in the high calorie biscuit throughout the shelf life period. The low water activity, a_w 0.17±0.01 observed in the biscuit is an added advantage to extend the shelf life for six months at 28°C ±1 of storage with no added preservatives and other food additives.

Key words: pearl millet, high –calorie food, emergency food

1. INTRODUCTION

Lifestyle modification related to change in the eating quality and quantity led to the prevalence of non-communicable diseases. Supply of adequate nutrition for athletes, security forces and calamity victims who has faced disaster situations is also crucial. A biscuit which includes variety of ingredients proved to be a prominent vehicle for incorporating functional ingredients like, whole grains and highly nutritious underutilized minor cereal like pearl millet along with dairy ingredients like milk powder. It concentrates nutritionally complement, high energy (Energy > 300 kcal/kg) and counterbalance each other to form a wholesome snack.

Pearl millet contains substantial amount of minerals such as iron, calcium, zinc and high level of fat. It is nutritionally comparable and even superior to major cereals due to high energy and protein value (Fasasi., 2009). It is also a rich source of dietary fiber and micro nutrients while starch is the major constituent of pearl millet (Sehgal., et al., 2007). As a food source, it is non-glutinous and non-acid forming, so as soothing and easy to digest (Amit., et al., 2018). Millet is a superior cereal with regard to nutritional quality and presents several health benefits (Krishnan., et al., 2011). Moreover, millet is a potent source of antioxidants, due to its phenolic content and is a staple food substitute for celiac patients (Udaybeer., et al., 2017) This study focused on developing shelf stable ready to eat snack from locally available raw materials as an emergency food for athletes, security forces and calamity victims.

2. METHODOLOGY

A. Materials

Ingredients: Wheat flour, pearl millet flour, pearl millet grits, powdered corn seeds, milk powder, fat, sugar, glucose syrup, baking powder, biscuit ammonia, vanilla.

B. Product development

In this study three types of biscuit formulae were developed and finally the best formula was selected based on acceptance of the sensory evaluation. The product formulation was developed by substitution of wheat flour on W/W basis using multigrain flour (pearl millet flour and corn seed flour) based on sensory evaluation. The prepared multigrain flour was then mixed with other ingredients. The sugar and fat were blended without affecting the sensorial perception.

Dry ingredients were mixed well in a dough mixture (Model: Hobart CE-100). Then fat and sugar were creamed. Glucose syrup, mixed dry ingredients and vanilla were also blended to make dough. Finally, dough was flattened into round shapes and baked in an oven at 180°C for 20 min.

C. Chemical, Physical and Microbiology analysis

1) Proximate analysis:

Moisture content was determined using an oven dry method according to Association of Analytical Chemists (AOAC-2000). Protein content was analyzed using Kjeldhal method (AOAC -2010) while crude fat content was determined using Soxtherm (AOAC-2010). Crude fiber was determined using Fibertec instrument (AOAC-2010). Ash content was determined by Muffle furnace (AOAC-2010). Carbohydrate was calculated by subtracting the sum of moisture, protein, ash, fiber and fat from 100. Energy value was determined using - Oxygen Bomb Calorimeter (ASTM D 240).

2) *Chemical analysis:*

Dietary fiber content was determined using enzymatic gravimetric method described by (ASP, et al., 1983) . The change in chemical parameter in the form of free fatty acid was determined according to AACC (American Association of Cereal Chemists) official methods of analysis.

3) Physical analysis:

Water activity was determined using water activity meter (AQUA LAB). Colour and texture were determined using chromo meter (CR-400) and penetrometer respectively.

4) Microbiology analysis:

Microbiological evaluation was done for initial samples at beginning of the study and at the three weeks intervals during storage. Total plate count, yeast and mold count and Coliforms were analyzed according to SLS 516 parts I, II and III (2013) respectively.

E. Sensorial analysis

Sensory evaluation was conducted initially and at three week interval during the three months of storage period. Samples were served in individual plates, codified with a three-digit number, to 12 trained panelists. The samples were evaluated using a preference test based on a nine point hedonic scale (9 = like extremely and 1 = dislike extremely). Appearance, Taste, Color, Odor, Texture and

Overall acceptability were measured based on their evaluations.

F. Shelf life study

An accelerated shelf life was carried out for 12 weeks, by storing the high calorie biscuit, packed in a suitable packaging under four different temperatures (28°C±2, 37°C±2, 42°C±2, 50°C±2).

G. statistical analysis

Sensory acceptability data were statistically analyzed via Friedman test available in minitab 14. Shelf life of the product was calculated based on $k[A]^n = d[A]/ dt$ (Labuza 1982).

3. RESULTS AND DISUSSION

The high calorie biscuit developed was complied with the requirements given in the SLS (Sri Lanka Standard) 251:2010, Specification for Biscuits (Table 1).

Table 1: Chemical requirements for biscuits

Characteristics	Requirement	High calorie biscuit
Moisture, percent by mass, max)	*4.0	3.63±0.1
Acid insoluble ash (on dry basis) percent by mass, max	0.05	Not detected

The chemical analysis revealed that the high calorie biscuit is consisted of 67.39±0.1% carbohydrate, 16.88±0.1% crud fat, 6.53±1.6% protein, 0.98±0.9% crude fiber, 2.47±0.8% ash and 447Kcal energy. Water activity (a_w) and dietary fiber content of high calorie biscuit were 0.17±0.01 and 3.51±0.03% respectively.

Sensory properties such as appearance, taste, color, odor, texture and overall acceptability of the initial product was scored high rates (Figure 1) and accepted by 12 trained panelists.

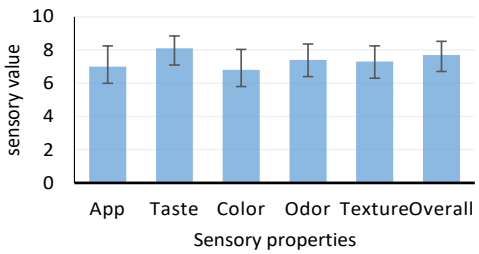

Figure 1: Sensory properties of high calorie biscuit

The moisture content was significantly increased during the shelf life period since; moisture can be absorbed through weak sealing points in the packaging.0 In foods, lipid peroxidation and enzymatic hydrolysis cause shelf life problems (Jaspreet, et al., 2014). The most limiting factor in determining the shelf life of dehydrated convenience mixes is the auto oxidation of fats and oil causing off flavors (Semwal, et al., 1999). Pearl millet is well identified for its high fat content. Fat and oil contribute to the tenderization of backed products through inhibition of gluten development and starch gelatinization (Thivani, et al., 2016). Free fatty acid (FFA) content of high calorie biscuit was not significantly ($p>0.05$) changed during the study as shown in Figure 2.

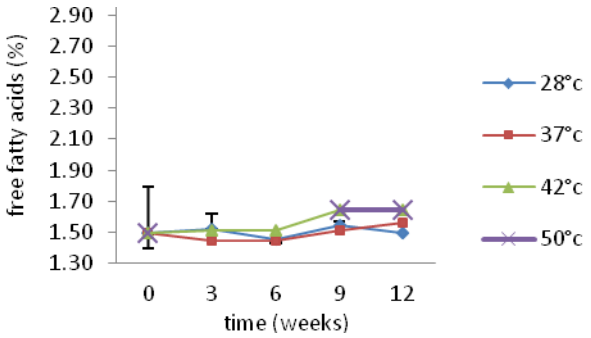

Figure 2: Variation in Free fatty acid content in high calorie biscuit during storage

The pearl millet biscuits have light and crispy texture, because of their gluten free nature (Florence, et al., 2014). The biscuits maintained the initial hardness satisfactory for at least 6 months of storage, independent of temperature (Mariana, et al., 2018). Hardness of a biscuits is based on its water activity and crunchy foods showed changes in hardness when the water activity exceeded the range of 0.35-0.50 (Katz & Labuza, 1981). However, the high calorie biscuit developed, did not exceed this limit of water activity. The texture of high calorie biscuit was significantly different ($p<0.05$) compared to reference sample from six weeks onward during the storage period (Figure 3).

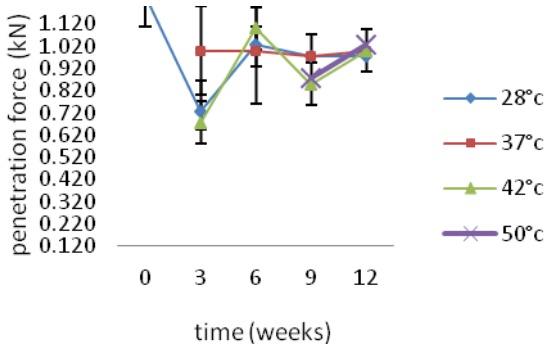

Figure 3: Variation in texture of high calorie biscuit during storage

Golden brown colour of the biscuit reduced significantly ($p<0.05$) in samples stored at all temperatures (28°C, 37°C, 42°C, 50°C) as shown in Figure 4.

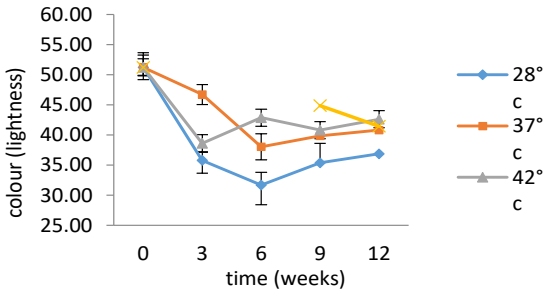

Figure 4: Variation in colour of high calorie biscuit during storage

A. Sensory analysis

Organoleptic characteristics of the biscuits were slightly changed during the storage period. This may be due to the non-enzymatic reaction (Millard reaction) and fat oxidation (Sujirtha&Thevaki, 2015).

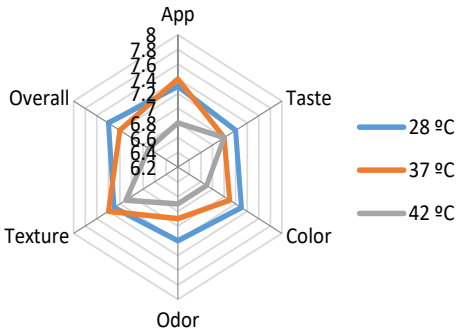

Figure 5: Sensory quality of biscuit after three week

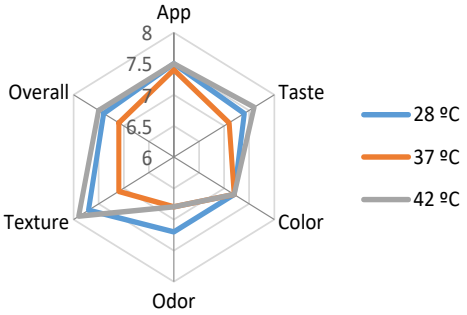

Figure 6: Sensory quality of biscuit after six week

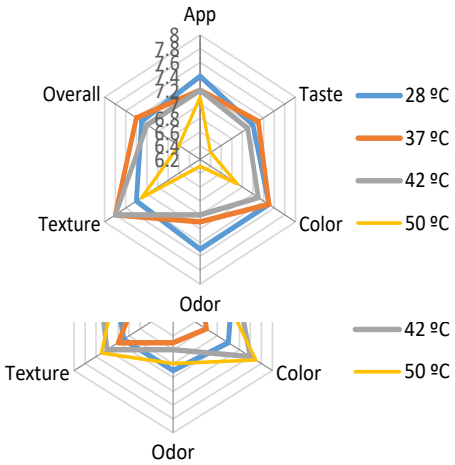

Figure 7: Sensory quality of biscuit after nine week

Figure 8: Sensory quality of biscuit after twelve week

Sensory analysis revealed that no significant difference in scores during the 12 weeks' storage (Figures 5 to 8). The appearance, color, taste and odor of sample stored at 42°C was significantly different ($p<0.05$) compared to the references (28°C) after 3 weeks' storage onwards. All samples stored above ambient conditions were significantly different ($p<0.05$) compared to the reference

(28°C) from 9 weeks onwards. Texture was significantly different from reference sample from six weeks onwards. The overall acceptability was significantly different ($p<0.05$) from three week onwards.

A. Microbiological analysis

Microorganisms play a significant role in shelf life study. They are usually responsible for spoilage of many food products. The microbiology quality of high calorie biscuit during storage period is given in table 2.

Table 2: Microbiology quality of high calorie biscuits during storage

Microbiology test	Satisfactory (cfu/g)	Weeks			
		0	3	6	9
Aerobic Plate Count	$<10^4$	ND	7×10^1	2.8×10^2	1×10^2
Yeast and Mold Count	$< 10^3$	ND	ND	ND	ND
Coliform Count	$< 10^2$	ND	ND	ND	ND
E coli	0	ND	ND	ND	ND

ND-Not Detected

No yeast and mold counts and coliform count were detected in microbiological studies conducted on yeast and mold, total plate count and coliform for high calorie biscuit during the storage period (Table 2). However, total plate count of bacteria was detected but much lower than the permissible limits. A high aerobic plate count could indicate the presence of mixed population of microorganisms, which may consist of spoilage types. The product should however be well kept after processing in suitable packaging materials capable of preventing contamination and hence subsequent proliferation of spoilage microorganisms (Fawole&Oso, 1998).These findings proved that the product is safe to consume due to the proper hygienic considerations during the preparation of high calorie biscuits.

2. CONCLUSION

The result of this study indicated that, high calorie biscuit can be used as an emergency food for calamity victims and it supply adequate nutrition for athlete with 212 days (7 months) storage period in triple laminated metalized packaging material (CPP 25µ, Al 9µ, polyester 12 µ) at ambient conditions (28°C±1) without chemical preservatives.

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