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Effect of Batter Ageing on Microbial, Physiochemical Changes and Sensory Quality of *Sel-roti*

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Sel-roti is a deep-fat fried, puffed, circular spongy doughnut like indigenous,non- alcoholic fermented cereal product of Nepal. A study was conducted to study the effect of batter ageing on physiochemical and microbial changes and its impact on sensory quality of Sel-roti.Ten samples of batters were aged for 9 h at 3 h interval at temperatures30°C, 40°C and 50°C.After ageing, acidityas lactic acid, reducing sugar and total sugar contents of the batter had increased significantly (P<0.05). The total sugar content of the batter started to decrease after 6 h of ageing. During the ageing period of 3 hour bulk density of products were decreased significantly (p<0.05) for all temperatures of ageing but after 3 hours of ageing it was increased slightly for 40°C. Fat uptake of sel-rotifound to decrease as ageing proceeds. Lactic acid bacteria, yeasts and mold co-existed in sel-rotibatter. LAB and yeast count at the end of 9 hour of aging was higher at 30°C than at 40°C. LAB and yeast count at 50°C was markedly decreased during 9 hour of ageing of batter. Mold count in the samples of batter during aging was decreased at all temperatures. Among study time and temperature of ageing quality of sel-roti prepared from batter aged at 30°C for 6 hour was found to be good in terms of sensory quality and cost effectiveness.

Keywords:*Sel-roti* batter,Ageing, Sensory quality, Physiochemical property, Microbial quality

Introduction

A global interest in rice and its fermented product is increasing due to their calorigenic value, unique quality characteristics and high acceptability. The Nepali people of the Himalayan regions of India, Nepal, and Bhutan prepare a fermented rice based cereal food called *sel-roti*. *sel-roti* is a delicious, deep-fat fried, puffed, ring shaped spongy doughnut like Nepalese indigenous food prepared from the batter of rice flour, ghee and sugar. *Sel-roti* is consumed in religious festivals and special occasions (Yonzan and Tamang, 2010).

Nepal is a country of ethnical, cultural, religious and linguistic diversity. Therefore, diverse kinds of traditional foods can be found in Nepal, which the people have inherited from their ancestors. *Sel-roti* is a local Nepali name given to the ring shaped spongy doughnut like Nepalese indigenous food usually prepared by deep-fryingthe batter made up of rice flour, cream or ghee (clarifiedmilk fat), sugar and water in ghee or any other cooking oil.Ageing of *sel-roti* batter has positive effect on the appearance, eating and textural quality of *sel-roti* (Katawal and Subba, 2008). Effect of batter ageing on biochemical and sensory characteristics of *sel-roti* is still not studied and documented. On the other hand Nepal, being a member of WTO has to register its indigenous products such as *sel-roti*. The first step to claim the "Intellectual Property Right" of *sel-roti*requires its scientific study. As the traditional method of *sel-roti* preparation technology has been commercialized these days, a proper processing technology helps to produce quality and uniform product.The objective of the research was to study the effect of batter ageing on physiochemical and microbial changes and its impact on sensory quality of *sel-roti*.

Materials and Methods

Old (*Kanchhi mansuli*) rice, ghee (Sujal Dairy Private Limited, Pokhara) and frying oil (Cello brand refined Sunflower oil) were purchased from local market of Dharan, Nepal. Recipe for the preparation of *sel-roti* was Riceflour: 100 g, Sugar: 21 g, Ghee: 10.5 g and Water: 25 mL. Figure.1 shows the method of preparation of *sel-roti*.The rice was winnowed with the help of *Nanglo* and cleaned with water for 2 times. Water was added and was allowed to stand for 2 hours. The water was drained from the soaked rice and ground into flour. The flour was sieved by using ASTM standard set of sieve with clear opening of 600 μ (Pradeep Trading Co. Delhi). The flour retained in sieve was collected and weighed. Based on the particle size the rice flour was divided into two groups as coarse (>600 μ) and fine (<600 μ). For the preparation of

sel-roti, 30% coarse flour and 70% fine flour were mixed and taken. Sugar, ghee and a little water was added onto the flour. It was kneaded with palm for about 20 minutes and allowed to stand for batter development. Sufficient water was added and whipped with hand. Then, the batter was poured into heated oil, giving into the circular shape. Frying was done at 210˚C (initial). Total time of frying was 35 second; upside was turned down after 19 second and finally removed with the help of *Jheer,*which is a local word for a pointed bamboo stick.

After preparing batter as above it was aged at different temperatures for above mentioned time periods.Physical, Chemical and microbial analyses of samples of batter (aged for given time and temperature) were done to study

Process	Notes
Rice	
Cleaning	
Soaking	* for about 2 hours in potable water
Draining	
Grinding/powdering	*in *Khalbacha* or grinder
Sieving *optimum particle size (Particle size <600µm 70% + >600µm 30%)	
Mixing	*ghee and sugar
Kneading /rubbing well	*about 20 minutes
Batter preparation (25 mL/100g* flour)	*Adding water in adequate amount
Ageing the batter	*at 30˚C, 40˚C and 50˚C for 3h*, 6h and 9h
Frying in oil	*at initial 210˚C, total time 35 second, by turning other side by means of *jheer* after 19 second
Sel-roti	
Ready to serve	

Figure 1. Flow chart for the preparation of sel-roti

the effect of ageing on the batter.

Sel-roti was made from different samples of *sel-roti* batter and sensory analysis was done to study the effect of batter ageing on sensory quality of *sel-roti*.

Fat content of samples of *sel-roti* and rice flour was determined to calculate oil uptake by *sel-roti*.

Oil-uptake was calculated as follows:

$$\text{Oil uptake} = \frac{\text{Percent Fat Content}}{100 - (\%\text{Moisture content} + \%\text{fat})} \text{ X } 100$$

(% Dry & fat free basis)

Bulk density of *sel-roti* was determined by volumetric replacement method using mustard seeds of almost same size as the replacement medium (Nepal Standard 2036 B.S.). A wooden box suitable for the measurement was designed for this purpose. The bulk density of *sel-roti* was calculated using the formula:

$$\rho_s = \frac{Ws}{Wm} \text{ X } \rho m$$

Where ρ_s= bulk density of sel-roti(g/cc);

W_s = weight of sel-roti (g);

W_m = weight of mustard seeds with the same volume as that of the Sel-roti (g); and

ρ_m = bulk density of mustard seeds (g/cc).

Moisture content,protein,reducing sugar, pH and titrable acidity weredetermined as described in AOAC (2005). Fat, total sugar contentwas determined by the standard procedure as mentioned in Rangana (2007). Total carbohydrate was determined by difference method.Ash was determined in muffle furnace at 500°C as described in Pearson (1976).Potato dextrose agar and yeast extract-malt extract agar was used for examination of molds and yeasts, respectively. Lactic acid bacteria (LAB) were selectively isolated on MRS agar as described by Harrigan and McCance(1979). Sensory evaluation(by 12 panelists comprising teachers and students of Central Campus of Technology, Dharan) was performed according 9 point hedonic rating test (9 = like extremely, 1 = dislike extremely) for color, smell, texture, taste and overall acceptance for coded samples rinsing their mouths between tests. Three replicate data obtained was analyzed by ANOVA and t-test using features of GenStat Discovery Edition 3 (GenStat Release 7.22 DE) and means were compared by L S D method at 5% level of significance.

Results and Discussion

Composition of s*el-roti* batter

Table 1 shows the proximate composition of freshly prepared *sel-roti* batter. The composition was calculated on the average of three samples.

Table 1. Proximate composition of freshly prepared sel-roti batter

Parameters	Values (%
Moisture	34.23±0.43
Total carbohydrates	83.05±0.48
Protein	5.43±0.32
Fat	10.65±0.38
Crude fiber	0.16±0.001
Ash	0.7±0.015

All values are on dry basis except moisture
Values are arithmetic mean of the triplicate samples ±standard deviation

Effect of ageing on acidity and pH of the *Sel-roti* batter

The effect of ageing on acidity of the *sel-roti* batter is presented in Figure 2. Acidity of freshly prepared *sel-roti* batter was 0.09% (as lactic acid). Yonzan and Tamang (2010) also reported similar value (0.08±0.01). As the time of ageing increased, the acidity in the batter was also increased due to production of lactic acid. Initially the increasing trend was slow where as it is faster at the later periods of ageing. During 9 hour of ageing, the acidity of the batter had increased from 0.09 to 0.15, 0.19 and 0.124 (as lactic acid) for 30°C, 40°C and 50°C respectively. Consequently, there was a gradual fall in the acidity of the batter after 3 hr of ageing time at 50°C. The later slow decrease in the acidity at 50°Cmight be due to retardation of growth of mesophilic organisms at that temperature. That might be due to proteolysis of protein at that temperature. Moulay *et al.* (2006),Law and Kolstad (1983), Savijoki *et al.* (2006) and many others reported the proteolytic activity of lactic acid bacteria. *Leuconostoc mesenteroides, Enterococcus faecium, Pediococcus pentosaceus* and *Lactobacillus Curvatus* are *the* most dominant lactic acid bacteria of *sel-roti* batter (Yonzan and Tamang, 2010). Evidence for extracellular proteolytic activity in *Lactobacillus curvatus* was also demonstrated by Pereira *et al.* (2001).

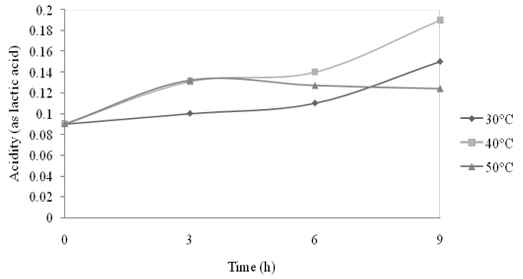

Figure 2. Effect of ageing on acidity of sel-roti batter

The effect of ageing on pH of the sel-roti batter is presented in Figure 3. pH value of freshly prepared batter was found to be 0.58 which was similar value found by Yonzan and Tamang(2010). During 9 hour of ageing, the pH of the batterhad decreased from 5.8 to 5.09, 4.56 and 5.4 for 30°C,40°C and 50°C respectively.

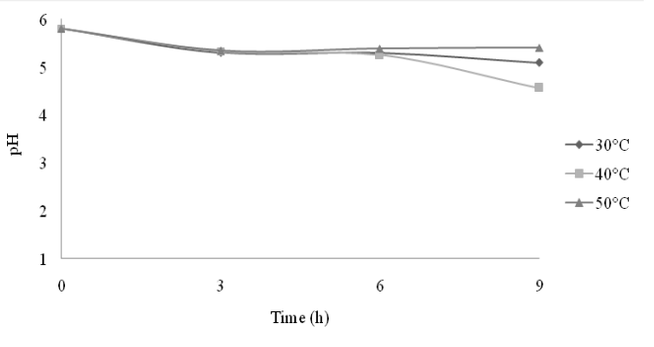

Figure 3. Effect of ageing on pH of *sel-roti* batter

Effect of ageing on reducing sugar and total sugar content of *sel-roti* batters

The effect of ageing on reducing sugar and total sugar content of the *sel-roti* batter is presented in Fig. 4 and Fig. 5 respectively. The initial reducing sugar content of *sel-roti* batter was found to be 0.33%. During 9 hour of ageing, it had increased to 0.64 %, 0.59 % and 0.75 % for 30°C, 40°C and 50°C respectively. The slightly lower rate of increase of reducing sugar at 30°C and 40°C can be understood as higher rate of consumption of fermentable sugar at these temperatures during ageing.

Total sugar content of *sel-roti* batter was increased during first 6 hour of ageing from 14.83% to 15.85%, 15.97% and 16.34% for 30°C, 40°C and 50°C respectively. The initial increment of total sugar content indicates hydrolysis of polysaccharides into simple sugar which might be due the effect of enzymes produced by mold present in the sample of *sel-roti* batter. The later decrease in total sugar content after 6 hour of ageing indicates the utilization of fermentable sugar by microorganisms to produce different metabolites.

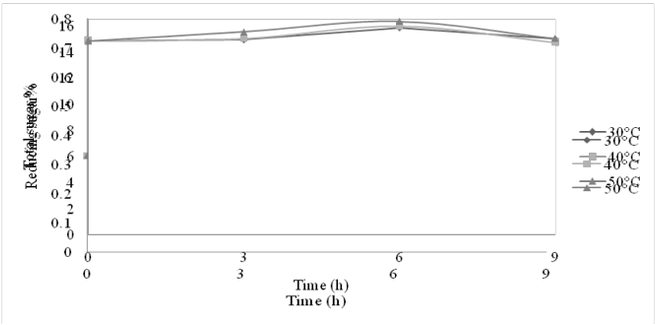

Figure 4. Effect of ageing on reducing sugar content of sel-roti batter

Figure 5. Effect of ageing on total sugar content of sel-roti batter

Bulk density

Bulk density of samples of *sel-roti*was determined to study the effect of s*el-roti*batter ageing onbulk density of product and the effect is presented in Figure 6.

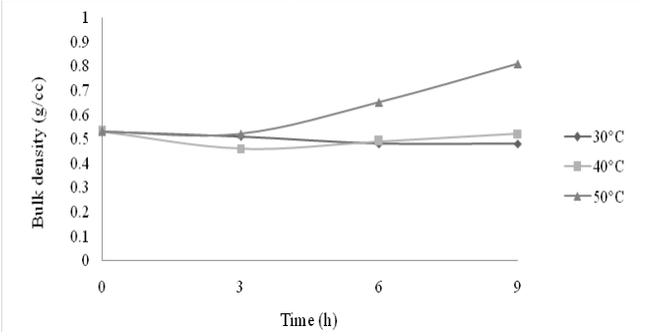

Figure 6. Effect of batter ageing on bulk density of sel-roti

The bulk density of the product prepared from the fresh sample of *sel-roti* batter was 0.53 g/cc. The value was near about that found by Katawal and Subba (2011). The above fig 4.5 shows that during the ageing period of 3 hour bulk density of products were decreased for all temperatures of ageing (30°C, 40°C and 50°C). But after 3 hours of ageing it was increased slightly and reached up to 0.52 g/cc for 40°C. There was sharp increment of bulk density of *sel-roti* prepared from the samples of batter aged at 50°C. The graph shows that there was continuous decrease on bulk density of *sel-roti* prepared from the sample of batter aged at 30°C. That might be due to the effect of fermentation by yeast as that temperature is optimum for yeast.

Fat-uptake

Fat uptake of the products (Dry and fat free basis) prepared prom the samples of batters aged for different conditions were shown in Figure 7. The value for the *sel-roti* from freshly prepared batter was 27.01%. The value was quite lower than that found by Katawal and Subba (2011). Katawal and Subba also reported that *sel-roti* made from rice flour containing smalleror finer particles absorbs more oil or fat and vise versa. The reason of lower fat uptake of these products was probably due to presence of course particle of flour in the recipe.

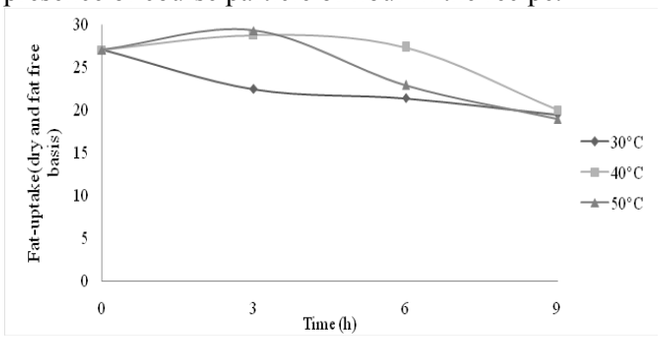

Figure 7. Effect of batter ageing on fat-uptake

Figure 7 shows that fat-uptake decreases with increase in ageing time which might be due to production of lactic acid as ageing proceeds. Mahmod *et al.* (2008) reported that the use of acetic and lactic acid in rice causes a decrease in oil penetration.

Microbial analysis

The microbial population of LAB, yeast and mold in freshly prepared batter were 10^4, 10^3 and 10^6cfu/g of sample. Similar result was found by Yonzan and Tamang (2010) where the microbial populations of LAB and yeasts were 10^4 - 10^8cfu/g and 10^4 - 10^5cfu/g, respectively. The initial mold count of freshly prepared batter was 10^6cfu/g. Mold was not detected in the sample of batter by Yonzan and Tamang (2010). High mold count in the sample of batter in this study might be due to contamination from sugar used in the recipe.

The effects of ageing on the microbial population of batter were shown in Figure 8, Figure 9 and Figure 10. Figure 8 and Figure 9 show that microbial population of LAB and yeast were increased with ageing period at 30°C and 40°C. LAB and yeast count at the end of 9 hours of aging was higher at 30°C than at 40°C which might be due to more favorable condition of LAB and yeast growth at 30°C than at 40°C. LAB and yeast count at 50°C was markedly decreased during 9 hours of ageing of batter

as higher temperature retard and even kill vegetative microorganisms.

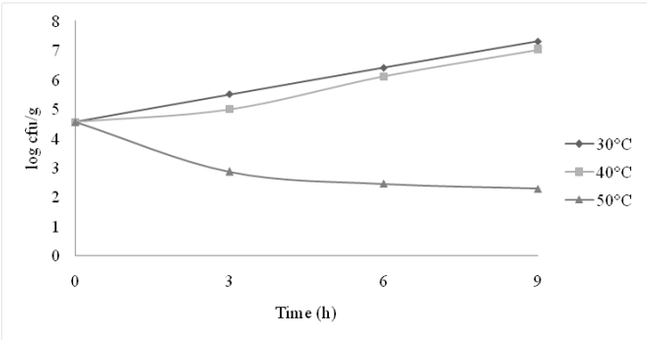

Figure 8. Effect of ageing on LAB count

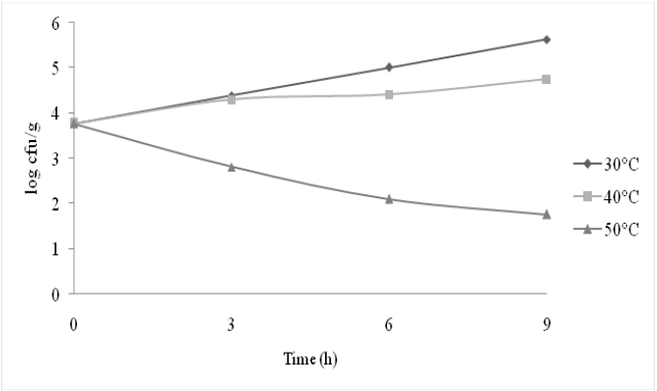

Figure 9. Effect of ageing on Yeast count

Figure 10 shows decrease of mold count in the samples of batter during aging at all temperatures (30°C, 40°C and 50°C) which might be due to antimicrobial activity of LAB. All strains of LAB isolated from Sel-roti batter showed antimicrobial activities under the applied condition (Yonzan and Tamang, 2010).

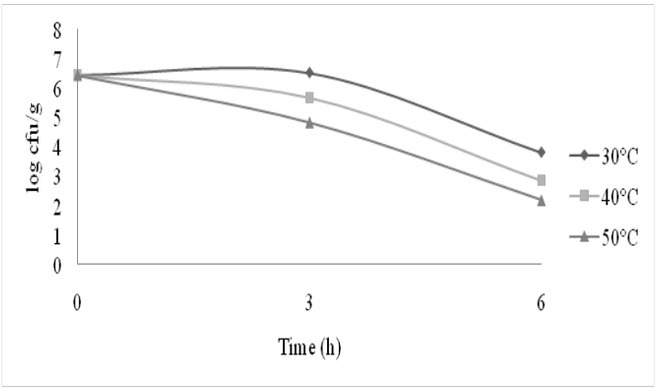

Figure 10. Effect of ageing on Mold count

Sensory quality of the product

To study the effect of ageing on the sensory quality of the*sel-roti*, ten products from the samples of batter with different temperature (30°C, 40°C and 50°C)and different time(0 h, 3h, 6h and 9h) of ageing was prepared and sensory analysis of the *sel-roti* was carried out.

The mean sensory scores of the products in terms of appearance,smell, taste, texture andoverall acceptability arepresented in Fig.11, 12, 13, 14 and 15 respectively. The mean sensory score in terms of appearance, smell, texture and overall acceptability of the s*el-roti* prepared from batter aged for 3 hour at 40°Cwere highest. The score were significantly different ($p<0.05$) from the mean sensory scores in terms of appearance, smell, texture and overall acceptability of other *sel-roti* but no significant difference ($p>0.05$) was observed from the s*el-roti* prepared from the sample of batter aged for 6 h and 9 h at 30°C. The mean sensory score in terms of taste of the *sel-roti* prepared from the batteraged for 3 h at 50°Cwas highest. That might be due to higher amount of residual sugar present in the batter. That score was significantly different ($p<0.05$) from the mean scores of taste of other *sel-roti* but no significant difference ($p>0.05$) was observed from the s*el-roti* prepared from the samples of batter aged for 6 h and 9 h at 30°C and 3 h and 6 h at 40°C .

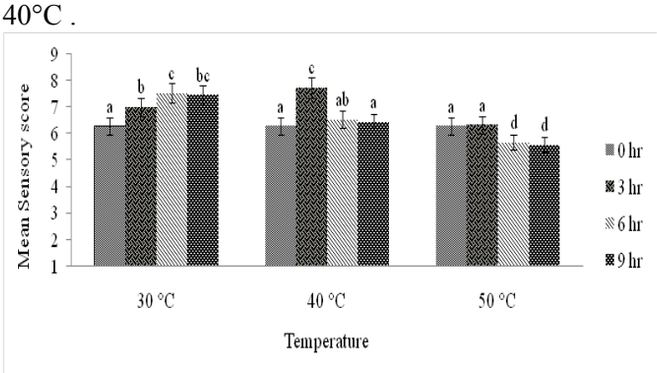

Figure 11. Effect of batter ageing on appearance of

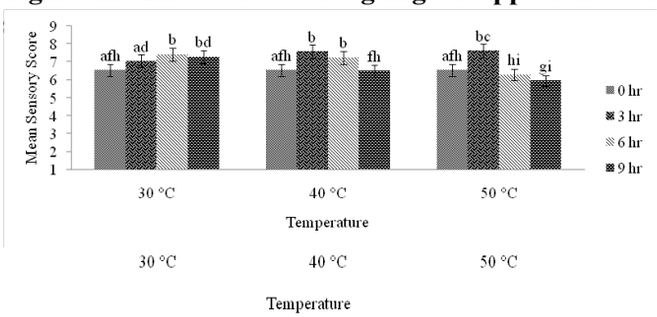

Figure 12. Effect of batter ageing on smell of sel-roti

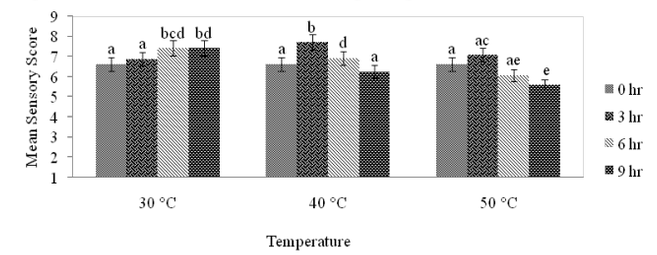

Fig. 13 Effect of batter ageing on taste of *sel-roti*

Figure 14. Effect of batter ageing on texture of sel-roti

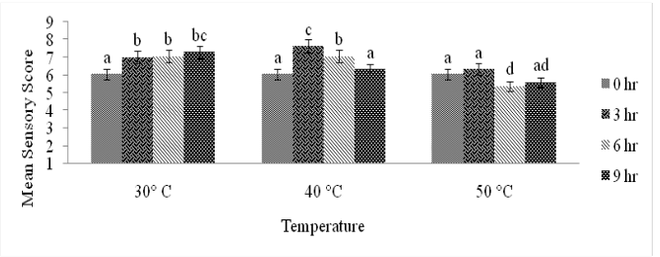

Figure 15. Effect of batter ageing on overall acceptability of sel-roti

Conclusions

As the time of ageing increased the acidity of the batter increased and pH decreased. During 9 hours of ageing, reducing sugar content of batter increased but total sugar content of batter increased up to 6 hours and then started to decrease. Sel-roti prepared from batter aged up to 3 h had lower bulk density. The bulk density increased after 3 hours of ageing at 40°C and 50°C. Sel-roti prepared from batter aged for 3 hours at 40°C and 50°C had higher fat uptake. Sel-roti prepared from batter aged at lower temperature i.e. 30°C or 40°C and 50°C for more than 3 hours had lower fat uptake.Lactic acid bacteria, yeasts and mold co-existed in Sel- roti batter enhancing the sensory quality of the product.Batter ageing had significant effect on quality of *sel-roti*.Among study time and temperature of ageing quality of *sel-roti* prepared from batter aged at 30°C for 6 h was found to be good in terms of sensory quality and cost effectiveness.

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