

Microwave Supplementation for Sustainable Development in Bakery Industry

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Abstract—The bakery industry has been steadily growing in the country, being the largest among the processed food industries. Bakery industry mainly uses conventional method (conduction, convection and radiation) for producing baked foods. However for sustainable development the electrical energy should be judiciously used and ways to conserve the electrical energy should be explored. Considering this, present study was planned to explore the use of microwave along with conventional baking for preparing cookies. Microwave cooks the food faster and it is expected that electrical energy would be saved. As cookies are liked by people of all age's, so cookies was selected as an ideal product for microwave supplementation. Cookies were prepared using a standard recipe using conventional baking and combination baking (using conduction, convection and microwave mode). Sensory score was found to be almost same as control cookies showing the acceptability by the panelists. Reduction in the baking time (BT) was by ~3 minutes was observed. Spread ratio and spread factor was observed more in microwave supplementation. This means that cost of production of cookies can be reduced by using microwave oven before conventional baking. It can be concluded that for technological development, an industrial oven with combination of conventional mode of heating along with microwave can be designed and more studies can be planned for sustainable development.

Keywords: Microwave Baking, Cookies and Sustainable development

1. INTRODUCTION

During conventional baking heat is transferred, mainly by convection, from the heating media and by radiation from oven walls to the product surface followed by conduction to the centre. There is also conduction from the product container and convection in the product by the movement of water vapour as the temperature rises. The heat penetration into the product may not be uniform as a result it leads to chances of side line burn or burnt bottom which lead to product loss and increased cost of production in the baking industries. Baking for long time also lead to loss of nutritional value in the product. This leads to the requirement of exploring other modes of heating and using combination ovens to develop product of required characteristics.

Microwave heating refers to the use of electromagnetic waves of certain frequencies (2450 or 915 MHz) to generate heat in a material through two mechanisms, dielectric and ionic. Because the time of heating is very fast in the microwave oven there may not be enough time for either starch gelatinization and final setting of the dough/batter into a rigid crumb structure. The net result is low quality microwave- baked products as fast heating eliminates

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the first stage of crust formation in the cookies. However considering the following advantages of microwave heating/baking it was planned to use microwave ovens along with conventional ovens for development of optimum quality baked products as per the industry standards:

1. Microwave baking provides a final product with higher nutritive value than conventional baking
2. Baking times are reduced and
3. Saves electricity/ energy cost as the baking time is less,
4. Microwave equipment requires less space,
5. Microwave cooking is convenient,
6. Precise process control,
7. Selective heating,

Although microwave baking renders some advantages over conventional baking but still there are quality problems in baked products which do not meet the expectations of the customers particularly lack of surface browning, flavour and crust formation in cookies hence represents challenge to food technologists. The colour problems related to microwave baking may be overcome by either using combination oven or by using flour blends with or without colour.

The combination heating provides selectivity that improves moisture distribution inside food by heating the surface of a food faster. Therefore, moisture can be easily removed from the surface of the product and the food remains crisp. Thus, this technology combines the browning and crisping advantages of conventional oven and the time-saving and energy efficiency advantages of microwave heating. Sumnu et al. (2005) determined the effects of different baking methods (microwave, infrared and infrared-microwave combination) on the quality of cakes. However, the use of microwave and conventional baking is to be explored in the cookies with respect to the reduction of baking time. Therefore, in this study it was not only aimed to optimize the baking conditions but also aimed to optimize formulations of cookie to be baked in microwave combination oven.

2. MATERIALS AND METHODOLOGY:

Flour and other ingredients were procured from local market, sieved through appropriate mesh sieve and were used for the study. All ingredients were stored at room temperature (33-37 °C) and used as per recommended storage condition. Analysis to check various physical and chemical characteristics were done on the raw materials as per approved methods.

Control cookies were prepared by a standard recipe used by S. Ranhotra and J. A. Gelroth (1986) as per AACC method 10-50D. Dough temperature is maintained as 32-34° C (preferred 32°C). Dough was formed as per standard methodology. Resting time of 15 min was given. Dough was rolled manually into 1 cm thickness. Cookies were cut in round shape with a diameter of 4.0 cm across. Control cookies were baked in a commercial baking oven with top temperature of 180 °C and bottom temperature 150 °C for 12-15 minutes, and cooled at a room temperature, Microwave supplemented cookies were baked in a microwave oven

operating at 75% power, and baking was first done by energy of microwaves then convection mode was used for colour development. The cooled cookies were sealed in a plastic bag until measurements were taken. The developed cookies were compared with the control cookies for baking time, including physical, sensory and textural characteristics of the cookies were studied and compared.

3. RESULT & DISCUSSION:

Baking time (BT)

Baking time (BT) refers to the time taken by the oven to bake or cook the cookie dough to a cookie with intended colour and moisture level. BT is very critical for any bakery industry as cost (electricity, manpower and overhead costs) are involved which have great impact on the price of the product (cookies). The study showed that when microwaves were used for initial cookie structure formation and moisture removal followed by conventional oven to develop the colour, baking time was reduced by 2 mins as is depicted from the table 1. In both the cases the product development was done at 180°C. Average baking time in conventional oven was 16minutes whereas with microwave supplementation the BT was reduced to 14 minutes.

4. PHYSICAL CHARACTERISTICS

Table 1 shows that microwave oven combination showed similar average expansion in diameter but not in cookie thickness. Spread ratio and spread factor were observed more in microwave supplementation. Microwaved cookies showed more spread than rise in thickness, which can even affect the sensory and textural aspects.

Table 1: Comparison of BT and cookie dimension of the cookies developed by two ovens

Conventional Oven				Microwave + Conventional Oven			
Baking Time							
16 min				14min			
Physical characteristics							
Expansion in thickness (in cm)	Expansion in diameter (in cm)	Spread Ratio	Spread Factor	Expansion in thickness (in cm)	Expansion in diameter (in cm)	Spread Ratio	Spread Factor
0.44	0.51	4.89	100.00	0.26	0.54	6.07	100.00

Sensory analysis

Table 2 shows an increasing trend in the sensory quality of the cookies cooked with microwave supplementation. Average overall acceptability score (out of 10) and total sensory score (out of 50) for conventionally baked cookies and microwave supplemented cookies was 6.90, 33.50 and 7.40, 34.90 respectively, showing the higher acceptability of microwave supplementation by the panellists.

Table 2: Comparison of sensory scores of cookie developed in two ovens.

Conventional Oven						Microwave + Conventional Oven					
Appearance & colour (10)	Aroma (10)	Texture (10)	Flavour & Taste (10)	Overall Acceptability (10)	Total (50)	Appearance & colour (10)	Aroma (10)	Texture (10)	Flavour & Taste (10)	Overall Acceptability (10)	Total (50)
7.40	6.50	5.50	7.30	6.90	33.50	7.50	6.90	6.00	7.10	7.40	34.90

5. TEXTURE ANALYSIS

The snap test was carried out with the texture analyser using a three-point bend rig method for texture analysis of the both cookies. The response of selected cookies to a bending force was measured for both samples along with an oat based cookie available in market. The hardness and fracturability which are the key textural parameters, are measured for all samples and results were compared between two baking methods. As per the results obtained and presented in table 3 the results of cookies physical characteristics specifically reduced thickness and spread in diameter in the microwave baked cookies are clearly visible as both hardness (4151.25g) and fracturability (15.61mm) are more as compared to cookies baked in conventional oven with average hardness (3081.4g) and fracturability (6.33 mm) respectively.

Table 3: Comparison of textural characteristics of cookies developed by two ovens.

Conventional Oven		Microwave + Conventional Oven	
Hardness (g)	Fracturability (mm)	Hardness (g)	Fracturability (mm)
3081.4	6.33	4151.25	15.61

6. CONCLUSION:

The cost of production of cookies can be reduced by using microwave oven before conventional baking. Microwave supplementation not only decreased the baking time but also gave better acceptability to the developed product.

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