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Development and process standardization of cookies incorporated with maltodextrin and its physicochemical evaluation

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Abstract
Baking industry in India is considered as one of the major industries in food processing. Baking products are gaining popularity as processed foods because of their availability, ready to eat convenience and reasonably good shelf life. Wheat based baked products like bread, cookies, and cakes are popular among the baked products. Among the bakery products, cookies are most significant. The present research was intended to standardize the process for preparation of cookies with incorporation of maltodextrin as a fat replacer. Maltodextrin used as fat replacer due its low calorie content as compare to hydrogenated fat. Demand for ready to eat processed foods with better shelf life, satisfying taste, ease of palatability high nutritional quality and low calories is increasing throughout the world because of growing urbanization, economy and increased employment in industrial and day to day changing life style of people. Bakery products like cookies are most important product due to less moisture and better shelf life. Cookies were prepared from wheat flour (maida), sugar, fat, maltodextrin, baking soda, ammonium bicarbonate and milk. Prepared cookies were analyzed for sensory properties. Sensory evaluation revealed that the T_3 sample, which contained 30 per cent maltodextrin as a fat replacer was the best. The nutritional study revealed that the selected sample (T_3) has moisture, fat, carbohydrate, protein, ash and crude fibre content of 1.3%, 8.96%, 83.82%, 2.97%, 1.28% and 2.061% respectively. The selected sample is superior in carbohydrate content and less in fat content than control sample (T_0). The energy value of the selected cookies sample is less than control sample. This was due to lower fat content in T_3 sample as compare to control sample.

Keywords: Cookies, maltodextrin, fat replacer, physicochemical evaluation

Introduction
Cookies are important food snacks for children and adults. However these are most commonly relished by school going children and adults. Cookies hold an important position in snack foods due to variety in taste, crispiness and digestibility. These are popular among all age groups especially in children's. Commercially available cookies are prepared from white flour that is nutritionally inferior to whole wheat flour (Hussain, 2006) [2].

"Cookie" is chemically leavened product also known as 'biscuit". Generally the term biscuit is used in the European countries and cookies in the USA. Biscuits and biscuit like products have been made, eaten by man for centuries.

Cookies are characterized with quite long shelf life, which results in their availability almost everywhere at any time. Therefore, the alteration of composition of cookies directed to enhancement their nutritive and/or functional properties. The basic composition of cookies enables a variety of different possibilities for achievement of dietary properties of the products with respect to type, share and function of three main components for cookie dough production: flour, fat and sugar. There are different possibilities for development and production of dietary cookies, from sugar replacement or reduction, over alteration of fat shares, composition and properties to enrichment of cookies with different functional components. (Jovanka *et al.*, 2013) [4].

Reducing dietary fat is the primary dietary goal for many consumers. Fat replacers are compounds incorporated into food products to provide them with some qualities of fat. Although consumers want foods with minimal to no fat or calories, they also want the foods to taste good. The development of reduced-fat foods with the same desirable attributes as the corresponding full-fat foods has created a distinct challenge to food manufacturers. (Ognean *et al.*, 2006) [5].

Fat is one of the important ingredients influencing the sensory characteristics of baked products. Attempts have been made to replace the fat with other food components in baked products to reduce the total calories as well as to enhance nutritional properties. Among the substituting materials, carbohydrates are widely used in baked products, partly because they have economic advantages over many other fat substitutes. Maltodextrin is widely used for partial replacements of fats in a variety of processed foods because of its ability to form a particle gel cream in food systems (Hye *et al*., 2001) [3].

Materials and Methods

All the chemicals and glassware used in this research work were of analytical grade (AR) and were used from the PG laboratory in the Department of Food Chemistry and Nutrition. Equipment required in the present investigation was available at the College of Food Technology, Vasantrao Naik Marathwada Krishi Vidyapeeth and Parbhani.

Raw Materials

The raw materials include Wheat Flour (Maida), Sugar, Fat, Baking soda, Ammonium Bicarbonate, and Milk were procured from local market.

Methods

Physical analysis of cookies

Cookies were analyzed for physical quality attributes. Weight (g), diameter (mm), thickness (mm), and spread ratio were determined following standard methods of (AACC 2000) [1].

Weight

The weight of cookies was determined by using digital weighing balance (AACC, 2000) [1].

Diameter

The diameter of the cookies was measured by using digital vemeir caliper (AACC, 2000) [1].

Thickness

The thickness of the cookies was measured by using digital vemeir caliper (AACC, 2000) [1].

Spread ratio

Spread ratio was calculated by dividing the average value of diameter by average value of thickness of cookies. (A.A.C.C., 2000) [1]

Chemical composition of cookies

Moisture

The moisture content in the sample was estimated according to the method of AOAC (1984). 5 gm of sample was taken in pre-weighed moisture box, dried at 105 ºC for 24hrs in hot air oven, cooled in desiccators again weighed. The difference in weight of moisture box represents the moisture content of the sample.

$$\text{Moisture (\%)} = \frac{\text{Difference in the weight}}{\text{Weight of the sample (g)}} \text{ X } 100$$

Protein

The protein content in sample was determined by using conventional Micro-Kjeldhal digestion and distillation procedure as given in AOAC (1984).

Reagents are (a) Catalyst mixture- A mixture of 100gm K_2SO_4, 20gm of $CuSO_4$ and 2.5gm of SiO_2, (b) Sodium hydroxide 40% (w/v), (c) Boric acid 2% (w/v), (d) Concentrated sulphuric acid, (e) Mixed indicator 2 parts 0.2% (w/v) Methyl red and 1 parts 0.2% (w/v) methyl blue in absolute alcohol, (f) Standard sulphuric acid (0.1N).

Procedure

0.5 gm of sample was weighed accurately and transferred to a Kjeldhal flask taking care to see that the material did not stick to the neck of the flask. The catalyst mixture of about 1g and concentrated sulphuric acid (5ml) were added. Then the flask in an inclined position in digestion chamber was heated for about 4-6 hours till the liquid became clear (green blue colour). Distillation The content in the flask were allowed to cool and the digestion material was transferred quantitatively to a vacuum jacketed flask of micro Kjeldhal distillation apparatus and the ammonia liberated by the addition of 10 ml of 40% NaOH on heating was absorbed in 20 ml boric acid containing 2-3 drops of mixed indicator in 100ml conical flask. The distilled off ammonia was titrated against 0.1N sulphuric acid. The blank was also run in a similar way.

$$\text{N (\%)} = \frac{\text{Normality of } H_2SO_4 \text{ X Volume of 0.1N } H_2SO_4 \text{ X 14 x 100}}{\text{Weight of sample X 1000}}$$

Crude protein (%) = N X 6.25

Fat

The fat content of the sample was determined by the procedure as described in AOAC (1984). 5 gm of sample was weighed accurately, placed in thimble and plugged with cotton. The extractor-containing thimble was placed over a pre weighed extraction flask (A). Fat content was determined by extracting the sample with solvent petroleum ether (AR grade 60-80 °C) for 8hr using soxhlets extraction procedure. After extraction the excess of solvent was distilled off and the residual solvent was removed by heating at 80 ºC in oven for 4-6 hours. The fat content was determined as below:

$$\text{Crude fat (\%)} = \frac{\text{Weight of flask (b)-weight of flask (A) X 100}}{\text{Weight of sample}}$$

Carbohydrate

Total carbohydrate in the samples was estimated by hydrolysis method as described in AOAC (1984).

Reagents are Conc. HCl (specific gravity 1.25), Fehling's solution

- Fehling's solution A: 34.64 gm of $CuSO_4.5H_2O$ was dissolved in 500ml of distilled water.
- Fehling's solution B: 173 gm of sodium potassium tartarate and 50 g of sodium hydroxide were dissolved in 500ml of distilled water. The Fehling's solution was prepared by mixing the equal volume of solution A and solution B. It was prepared fresh daily. Sodium Hydroxide 40% (w/v). Methyl blue indicator 0.1 % (w/v) in 95% alcohol. 3N HCl – 68.18 ml concentrated HCl was made up to 250 ml with distilled water. Dextrose 1%- 1 gm of dextrose was dissolved in 100 ml distilled water. Procedure: 2.5gm sample was taken in the flask and suspended in 200ml of distilled water. 20ml of 3N

HCl was added refluxed in an air condenser for 3 hrs. On cooling, it was neutralized with alkali to pH 7.0, filtered and volume was made to 250 ml with distilled water. The total carbohydrate in the filtrate was determined by titrating it with Fehling's solution (A & B, %ml each) using 1 ml of methyl blue indicator. Factor was worked out by titrating 1% dextrose with Fehling's solution. In each titration Fehling's solution in the conical flask was heated with a constant flame and titration was done with filtrate in the burette until the end point (Brick- Red colour) was obtained. The total carbohydrate content was calculated as under.

$$\text{Dextrose \%} = \frac{\text{Factor x 250 x 100}}{\text{Titrated value X weight of sample}}$$

Total carbohydrate (%) = Dextrose % X 0.9 24

Total Ash

The ash content in the sample was estimated according to AOAC (1984).

Procedure

5 gm of sample was weighed accurately into pre weighed porcelain (which has previously been heated to about 600 ^{0}C and cooled). The crucible was heated in a muffle furnace for 6-8 hours at 600-700 ºC. It was then cooled in desiccators and weighed. To ensure completion of ashing, the crucible was again heated in a muffle furnace for 1-2 hour, cooled and weighed. This was repeated till the consecutive weights were the same and the ash was almost grayish-white in colour.

$$\text{Ash (\%)} = \frac{\text{Weight of ash}}{\text{Weight of sample}} \text{ X } 100$$

Crude Fibre

Crude fibre of sorghum grains was determined by method of AOAC. (1975) [1]. Weigh 10 gm sample in a 250 ml beaker. Add 200ml of H_2SO_4 (1.25%). Boil for 30 minutes and during boiling adjust the volume 200 ml constantly with hot water. After 30 minutes, filter the residue. Wash residue with hot water. Again take residue in 250 ml beaker. Add 200 ml of NaOH (1.25%). Boil for 30 minutes, adjust volume 200 ml with hot water. Filter the residue and wash with hot water until the clear water comes. Wash with ethanol. Allow to dry and weigh in silica crucible. It was then heated in muffle furnace at 600 °C for 5-6 hours.

$$\text{\%Crude fiber} = \frac{\text{Weight before heating-Weight after heating}}{\text{Weight of sample}} \text{X100}$$

Results and Discussion

Table 1: Standardized recipe for cookies to standardize the recipe following variations were made

Ingredients	T_0	T_1	T_2	T_3	T_4	T_5
Wheat Flour (Maida) (g)	100	100	100	100	100	100
Sugar (g)	55	55	55	55	55	55
Fat (g)	45	40.5	36	31.5	27	22.5
Maltodextrin (g)	-	4.5	9	13.5	18	22.5
Baking Soda (g)	1.5	1.5	1.5	1.5	1.5	1.5
Ammonium Bicarbonate (g)	0.5	0.5	0.5	0.5	0.5	0.5
Milk (ml)	33	33	33	33	33	33

*Each value is average of three determinations

Table 2: Percentage of fat and maltodextrin used in cookies

Sample	Fat	Maltodextrin
T_0	100% (45g)	0% (0g)
T_1	90% (40.5g)	10% (4.5g)
T_2	80% (36g)	20% (9g)
T_3	70% (31.5g)	30% (13.5g)
T_4	60% (27g)	40% (18g)
T_5	50% (22.5g)	50% (22.5g)

The recipe of cookies was standardized by keeping Wheat Flour (Maida), Sugar, Baking soda, Ammonium Bicarbonate and Milk value constant and replacing fat by Sorghum maltodextrin at the rate of 10%, 20%, 30%, 40% and 50% in different samples of cookies. Then all the samples were prepared for sensory analysis.

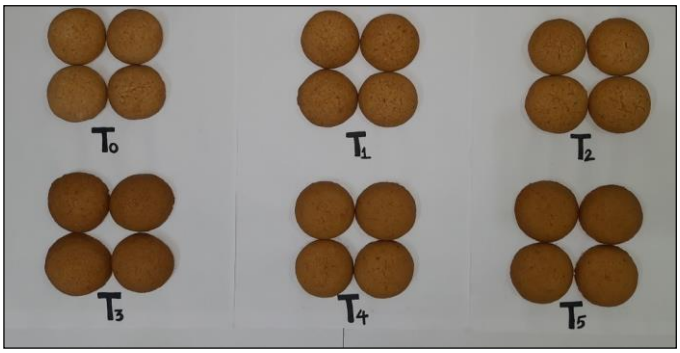

Fig 1: Prepared Samples of Cookies

Preparation of Cookies

Physical properties of prepared Cookies

Table 3: Physical properties of prepared Cookies

Sample	Weight (g)	Diameter (mm)	Thickness (mm)	Spread Factor
T_0	13.5	45.8	15.1	3.03
T_1	13.5	45.7	15.3	2.9
T_2	13.2	45.5	16.3	2.79
T_3	13.1	45.2	16.9	2.67
T_4	13.3	45.1	17.5	2.57
T_5	13.2	45	18	2.5

*Each value is average of three determinations

From the Table No. 4.2 it is evident that there was decrease in diameter and spread factor (ratio of diameter to thickness) and there was increase in thickness from control sample T_0 to sample T_5 was noted this was due to replacement of fat with maltodextrin in cookies preparation.

Proximate composition of prepared Cookies

Table 4: Proximate composition of prepared Cookies

Chemical Parameters	T_0	T_3
Moisture (%)	1.2	1.3
Total Fat (%)	22.05	8.96
Total Carbohydrates (%)	72.73	83.82
Total Protein (%)	2.91	2.97
Ash (%)	1.03	1.28
Crude Fibre (%)	0.151	2.061

*Each value is average of three determinations

The selected sample T_3 was recorded with higher value of protein, ash and crude fibre content compared to control

sample T_0 due to incorporation of maltodextrin as a fat replacer in sample T_3, maltodextrin contained trace amount of these nutrients i.e. protein, ash and crude fibre.

Theoretical energy value of Cookies

Table 5: Theoretical energy value of Cookies

Samples	Nutrients per 100g			
	Carbohydrate ×4	Protein× 4	Fat× 9	Energy value (Kcal/100 g)
Control	290.92	11.64	198.45	501.01
T3	335.28	11.88	80.64	427.8

From the Table No. 4.4 it is evident that cookies are unique source of energy as the total energy values obtained from control sample and T_3 were 501.01 and 427.8 kcal respectively. The energy value of the selected cookies sample is less than control sample. This was due to lower fat content in T_3 sample as compare to control sample.

Summary and Conclusion

The study was conducted to develop low fat cookies by incorporating maltodextrin as a fat replacer. Fat in Cookies was replaced with Maltodextrin at different replacement levels i.e. 10%, 20%, 30%, 40% and 50% in samples T_1, T_2, T_3, T_4, and T_5 respectively and these samples were evaluated with control sample (T_0). Sample T_3 was found to be most preferred sample with respect to sensory quality such as color, appearance, flavor, taste, texture and overall acceptability.

The selected sample (T_3) has moisture, fat, carbohydrate, protein, ash and crude fibre content of 1.3%, 8.96%, 83.82%, 2.97%, 1.28%, and 2.06% respectively. The energy value of final product was calculated and value 427.8 Kcal/100g recorded. The energy value of the selected cookies sample is less than control sample. This was due to lower fat content in T_3 sample as compare to control sample. The selected sample is superior in Carbohydrate and mineral content and lower in fat content than control sample. The selected sample T_3 was recorded with higher value of protein, ash and crude fibre content compared to control sample T_0 due to incorporation of maltodextrin as a fat replacer in sample T_3, maltodextrin contained trace amount of these nutrients i.e. protein, ash and crude fibre.

All samples were analyzed for weight, diameter, thickness, and spread ratio. There was decrease in diameter and spread factor (ratio of diameter to thickness) and increase in thickness from control sample T_0 to sample T_5 was noted.

Conclusion

On the basis of findings, it can be concluded that cookies prepared by incorporation of maltodextrin as a fat replacer could be considered as the best from both nutritional and sensory point of view. Thus it may be concluded that Maltodextrin can be successfully incorporated in the formulation of Cookies to reduce the calorie by replacing the fat. Low calorie cookies of acceptable quality can be prepared by incorporating maximum 30% maltodextrin in the formulation of cookies.

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