



Development of Process Technology for Laxative Biscuits

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Authors' contributions

This work was carried out in collaboration among all authors. Author SS managed the literature searches and performed the statistical analysis. Author ART wrote the first draft of the manuscript. Author MJ designed the study and managed the analyses of the study. All authors read and approved the final manuscript.

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ABSTRACT

Aims: The main objective of this study was to develop the whole wheat flour based castor oil fortified biscuits as per the maximum safe daily dosage of castor oil requirement for adults.

Study Design: In the present investigation attempts were made to prepare the whole wheat flour based castor oil fortified biscuits. As per the maximum safe daily dosage of castor oil requirement for adults, different levels of castor oil viz. 0, 10, 20, 30, 40, 50 and 56% were tried to prepare acceptable quality biscuit based on sensory parameters. The effect of variable amounts of castor oil in the biscuit formulation on dough and biscuit texture was also studied

Place and Duration of Study: Experiments were done in Department of Food Processing Technology, A D Patel Institute of technology, Gujarat (India) and completed within 8 months.

Methodology: The texture profile analysis for dough and biscuit samples prepared with varying levels of castor oil was carried out using texture analyser. Sensory evaluation of the prepared biscuit samples with varying % of castor oil was carried out for consumer acceptance and preference using semi-trained and consumer panelists.

Results: Dough with castor oil was observed to be significantly harder and less sticky. The hardness of the biscuits decreased with the increase in the level of substitution of castor oil. Overall

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acceptability of biscuits sample with 56% castor oil was the highest as compared to other samples and was significantly better than the control sample.

Conclusion: Overall acceptability of biscuits sample with 56% castor oil was the highest as compared to other samples and was significantly better than the control sample.

Keywords: Constipation; castor oil; biscuit; fiber; laxative.

1. INTRODUCTION

Constipation is one of the most common gastrointestinal complaints in all age groups. Pregnant women have constipation which is a common problem following childbirth or surgery. Change in lifestyle and gradual shift away from fiber rich diets calls for development of recipes, formulae and products that contain natural laxatives and restore the levels of dietary fiber thereby helping deal with constipation. Snack foods such as biscuits and crackers offer several important advantages including wide consumption, relatively long shelf life, good eating quality, highly palatability and acceptability in most countries.

Castor bean (*Ricinus communis* L) is cultivated for the seeds which yield viscous, pale yellow non-volatile and non-drying oil. It has been used only for industrial and medicinal purposes [1,2]. It is widely used as a human laxative-cathartic agent, particularly in cases of certain radiological examinations which require prompt and thorough evacuation of the small intestine [3,4.] Castor oil is one of the few naturally occurring glycerides with high purity, since the fatty acid portion is nearly 90% of ricinoleic [5].The oil is not only a naturally-occurring resource, it is also inexpensive and environmentally friendly. Relative to other vegetable oil, it has a good shelf life. However, to keep the quality of the oil, storage in cold conditions is not recommended. Limited information is available on the use of castor oilseed in the food industry. The oil is used as a mold inhibitor in food preservation and manufacturing of additives, flavors, and candy [6].

Castor oil is classified by Food and Drug Administration (FDA) as generally recognized as safe and effective for use as a stimulant laxative [7,8,9,10]. The components in Castor oil first act to stimulate the walls of both the small and large intestines. It is this purgative action of the colon walls which work to move impacted fecal matter through and relieve symptoms associated with constipation. Castor oil also has the ability to prevent the absorption of liquids from the

intestinal tract [11] This helps the bowel to retain more moisture, allowing for easier passage of fecal matter.

Bakery industry is the one of the largest food industries in India with an annual turnover of about \$3000 billion. The biscuit industry has been growing at an average rate of 15% during the past 3 years and this is expected to be maintained in coming years [12]. Breads and biscuits are major products accounting for 80% of the total bakery products in India [13]. The contributing factor about this is urbanization resulting in increased demand for ready to eat convenient products like breads and biscuits. Among convenience foods biscuits are very convenient and inexpensive but have only about 6 to 7% protein [14]. Its popularity is due to availability of varieties of products having different taste and texture profiles at reasonable cost with longer shelf life. A product was therefore formulated taking advantage of the wide market for biscuits and the health benefits of castor oil.

For the preparation of castor oil fortified biscuit, the refined wheat flour used for preparation of biscuits was replaced with whole wheat flour to provide benefits of fiber in addition to the laxative effect of castor oil. The main component of castor oil- Ricinoleic Acid, is responsible for causing the laxation in the intestine. The various other ingredients used in the preparation of the biscuit included shortening, sugar powder, baking powder, cardamom powder and water.

The main objective of this study was to develop the whole wheat flour based castor oil fortified biscuits as per the maximum safe daily dosage of castor oil requirement for adults.

2. MATERIALS AND METHODS

All ingredients viz. hydrogenated fat, sugar, baking powder, milk powder, essence, custard powder including Double Filtered Castor Oil and Whole Wheat Flour were commercially available and purchased from local market at Anand (Gujarat), India.

2.1 Modifications in Formulation for Laxative Biscuit

Attempts were made to optimize the formulation for development of laxative biscuits which provides the maximum safe daily dosage of castor oil requirement for adults. The maximum safe daily intake level of castor oil for adults for prevention of diarrhea and other side effects of castor oil is 15 ml (milliliter) per day [15]. The study aimed at providing this safe dosage, nearly 4 g provided in one 10 g weight biscuit. In the preliminary trials, changes were made in the overall composition, quantity of sugar, castor oil and flavoring compound added. Water was dependent on the treatment and ranged from 15-30% of weight of the flour. In the present investigation, the shortening content was replaced by castor oil on weight to weight basis to maintain a standard level of fat in the product viz. 0, 10, 20, 30, 40, 50 and 56% castor oil replaced the shortening on a weight by weight basis were studied. Also the standard formulation of biscuit given in Table 1 was modified to cooperate with the castor oil added in the biscuit. The quantity of sugar added was increased and the flavouring component used helped suppress the unpleasant aroma and flavor of castor oil. The solids content in the formulation was increased by increasing the skim milk powder content to obtain smooth and tough dough with desirable textural properties. The quantity of water added was also decreased with increase in the amount of castor oil added. These observations and changes were based on results of preceding experiments.

The proportions were based on a basic formulation in which a maximum of 56g castor oil and 24 g shortening in a 100 g composite could produce 20 biscuits each containing approximately 4 g castor oil.

2.2 Biscuit Preparation Process

The shortening, castor oil and sugar were creamed in a bowl, for about 15-20 minutes,

using an electronic mixer to form a light and fluffy mass which is white in appearance. The dry ingredients like baking powder, cardamom powder, whole wheat flour, skim milk powder were sieved twice to remove the impurities and mix the ingredients thoroughly. The dry ingredients were then added to the light and fluffy creamed mass and kneaded into soft and smooth dough, for 5 minutes, with addition of sufficient quantity of water. The dough was manually sheeted on a steel tray to a height of 5 mm (millimeter) using a wooden rolling pin and cut into circular shapes using a 5 cm (centimeter) diameter biscuit cutter. Butter paper was used to prevent dough sticking to the rolling pin. The cut dough pieces were transferred onto a baking sheet lined with butter paper. The biscuits were baked in a preheated air circulation oven at $160^{\circ}\text{C} \pm 2^{\circ}\text{C}$ for 25 ± 5 minutes and cooled for 30 minutes at ambient temperature (Kamaliya, 2001) Biscuits were packed in high density polyethylene bags and stored at room temperature.

2.3 Rheological Properties of Dough and Biscuit with Contribution

The TAPiustexture analyser (Lloyd Instruments Ltd, UK) was used to carry out the texture profile analysis for dough and biscuit samples. For dough, a 25 mm cylindrical probe was used for the analysis. The sample compression was at 45%, test speed was 1.0mm/s and trigger force was at 0.5N.

For biscuit, a 3 point bend setup with a 10mm diameter ball probe was used to test the hardness. The depression limit was 10 mm, test speed was 5mm/min and trigger set at 0.1N. Replicate of 3 biscuits were taken which were representative of the entire lot of the samples, used for the analysis, containing varying levels of castor oil.

Table 1. Standard formulation for plain biscuit

| Sr. No. | Ingredients | Percent (%) (flour basis) |
|---------|----------------------------|---------------------------|
| 1. | Flour | 100 |
| 2. | Shortening | 50-80 |
| 3. | Sugar (Powdered) | 50-60 |
| 4. | Essence | 0.25-0.5 |
| 5. | Baking Powder | 0.5-1 |
| 6. | Custard Powder/ Corn Flour | 5 |
| 7. | Milk Powder | 3-5 |
| 8. | Water | 15-20 |

2.4 Calculation for Recommended Daily Intake of the Biscuit

The safe level of oral consumption of castor oil per day is 15 ml. Density of castor oil used is nearly 0.910 kg/cm [3]. Therefore safe level of daily intake in grams would be as follows.

W.K.T,

$$D = \frac{M}{V}$$

$$M = D \cdot v$$

$$M = 0.910 \cdot 15$$

$$= 13.65 \text{ g}$$

“Where”,

D= Density of castor oil (kg/cm³)
 M=Weight of castor oil in grams (g)
 V= Volume of castor oil in millilitres (ml)

Nearly double the weight of biscuits is obtained when 100% weight of flour is used. From 100 g of flour taken, 20 biscuits are obtained on an average. The mean weight of each biscuit is 10 g. To obtain the recommended dosage for castor oil of 13.5 g in 4 biscuits the quantity of castor oil that needs to be added is 54 g in 100 g of flour. Therefore, the safe recommended consumption of biscuits is 4 every day for a period of 1 week.

2.5 Sensory Evaluation

Sensory evaluation of the prepared biscuit samples with varying % of castor oil was carried out for consumer acceptance and preference using semi-trained and consumer panelists, which included 20 males and 10 females aged 18 to 56 years, selected at random from A.D. Patel Institute of Technology Campus, Anand, Gujarat. Colour, texture, taste, after taste, appearance, flavor and overall acceptance of the products were rated using a 9-point hedonic scale where 9 and 1 represent extremely like and extremely dislike respectively. The mean scores were analyzed using analysis of variance (ANOVA) method and difference separated using Tukey HSD test.

3. RESULTS AND DISCUSSION

3.1 Rheological Properties of Dough and Biscuit with Contribution

The effect of variable amounts of castor oil in the biscuit formulation on dough texture is shown in Fig. 1. Dough containing less castor oil had significantly lower hardness and lower adhesiveness. Dough with 100% shortening (control) exhibited highest degree of softness.

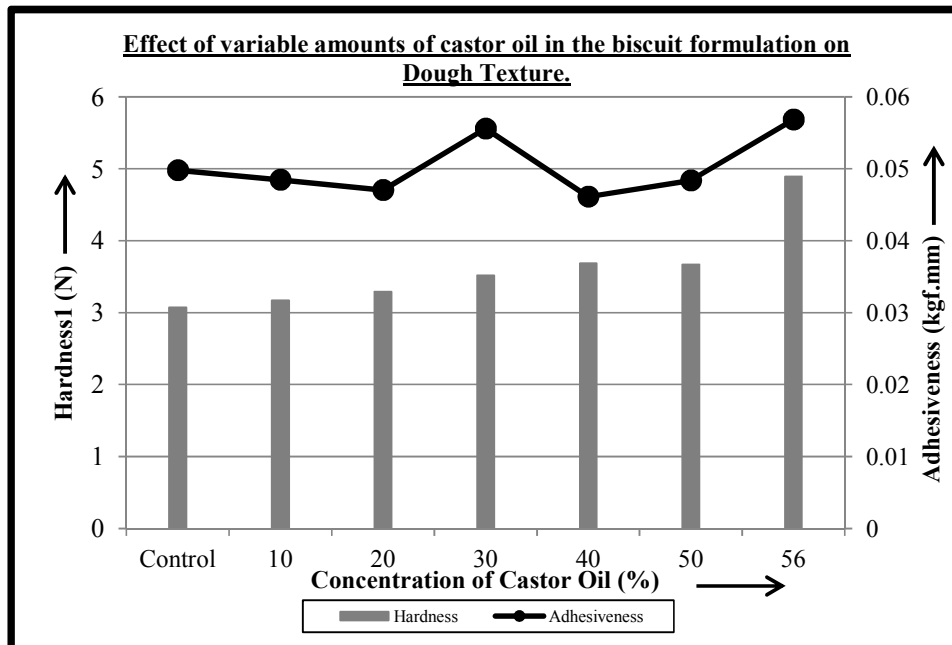


Fig. 1. Effect of variable amounts of castor oil in the biscuit formulation on Dough Texture (Hardness and Adhesiveness vs. Concentration of castor oil)

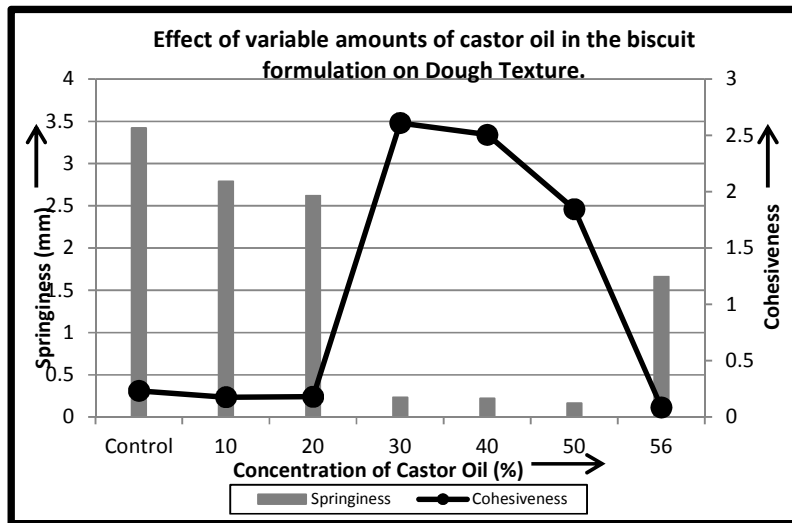


Fig. 2. Effect of variable amounts of castor oil in the biscuit formulation on dough texture (Springiness and Cohesiveness vs. Concentration of castor oil)

Similar trend was reported by Zoulikha [16]. From Fig. 2 it is evident that springiness and cohesiveness showed varied behavior with the level of castor oil added in the dough samples. In general, the dough became harder, more plastic and less sticky. Similar changes in rheological properties of dough due to replacement of shortenings were reported by Sudha [17]. The lubricating effect of the oil in combination with the shortening may be related to the textural changes in dough. The hardness may be attributed to the fact that less amount of water was required with increase in the amount of castor oil added in the dough.

Fig. 3 shows the relation of hardness of the biscuits with level of substitution of castor oil. The hardness of the biscuits decreased with the increase in the level of substitution of castor oil in the formulation. A similar decreasing trend was observed in the work done to break the biscuits due to the increase in level of castor oil added in the samples. The results are in line with the previous studies which stated that decreasing the fat content or substituting fat with different components has a huge influence on the texture characteristics of biscuits [18, 19].

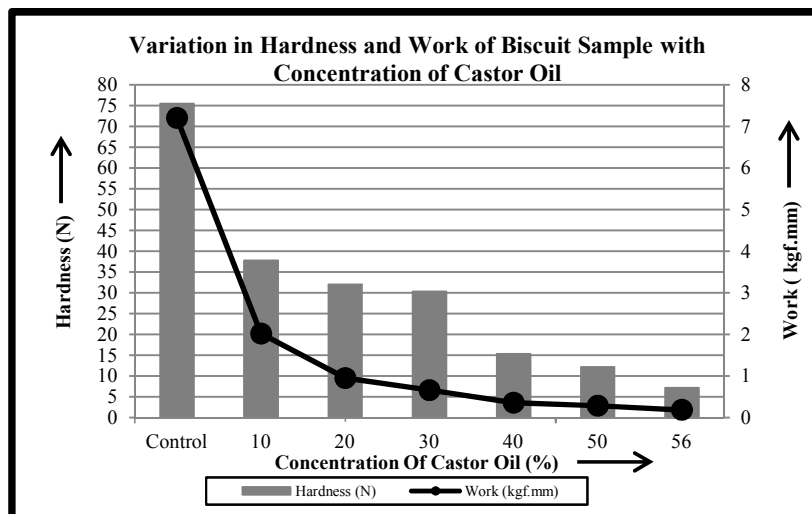


Fig. 3. Variation in Hardness and Work of Biscuit Sample with Concentration of Castor Oil (Hardness and Work vs. Concentration of castor oil)

Table 2. Sensory attributes of biscuits by different proportions of castor oil in the formulation

| Sensory Parameters*# | | | | | | | |
|-----------------------------|------------------------|------------------------|-------------------------|------------------------|-------------------------|------------------------|------------------------------|
| Attributes | Taste | After Taste | Texture | Appearance | Flavour | Colour | Overall acceptability |
| Control | 7.33±0.26 ^a | 7.42±0.20 ^a | 6.25±0.42 ^a | 7.25±0.42 ^a | 6.58±0.38 ^a | 6.83±0.26 ^a | 6.75±0.42 ^a |
| 10% Castor oil | 7.17±0.26 ^a | 7.25±0.42 ^a | 6.17±0.41 ^a | 7.00±0.45 ^a | 6.42±0.38 ^a | 6.42±0.38 ^a | 6.67±0.41 ^a |
| 20% Castor oil | 7.17±0.41 ^a | 7.00±0.45 ^a | 6.92±0.58 ^{ab} | 6.83±0.52 ^a | 6.83±0.26 ^a | 6.92±0.20 ^a | 7.08±0.49 ^a |
| 30% Castor oil | 7.33±0.26 ^a | 6.75±0.82 ^a | 6.92±0.58 ^{ab} | 6.75±0.52 ^a | 7.00±0.55 ^{ab} | 6.67±0.41 ^a | 7.00±0.55 ^a |
| 40% Castor oil | 6.67±0.52 ^a | 6.67±0.75 ^a | 7.08±0.74 ^{ab} | 6.92±0.38 ^a | 6.67±0.41 ^a | 7.33±0.52 ^a | 6.92±0.20 ^a |
| 50% Castor oil | 6.92±0.49 ^a | 6.92±0.74 ^a | 7.17±0.41 ^{ab} | 6.83±0.68 ^a | 6.92±0.20 ^{ab} | 7.00±0.32 ^a | 6.83±0.26 ^a |
| 56% Castor oil | 7.17±0.26 ^a | 6.83±0.75 ^a | 7.58±0.38 ^b | 6.92±0.38 ^a | 7.58±0.38 ^b | 6.83±0.26 ^a | 7.50±0.55 ^a |

*The data are average of 6 replications; # Mean scores on Hedonic scale 1-9 (1: dislike extremely, 9: like extremely)

3.2 Sensory Evaluation

Biscuits formulated with 10, 20, 30, 40, 50, 60 and 56% castor oil were subjected to sensory evaluation by panelists. The mean scores for color, flavor, texture, taste, after taste, appearance (shape and size) and preferences of overall acceptability of biscuits are presented in Table 2. Results revealed that there was no significant difference in taste, aftertaste, appearance, colour between the control sample (0% castor oil) and Samples prepared with varying % of castor oil. Texture of biscuit sample with 56% castor oil was most preferred and significantly better than the other samples. Biscuits prepared with 56% castor oil was observed to be most acceptable in terms of flavour compared to the control sample containing no castor oil and the other samples. Overall acceptability score of biscuits sample with 56% castor oil was the highest as compared to control and other samples.

4. CONCLUSION

Acceptable quality biscuits can be prepared by incorporation of castor oil with substituting shortening in the formulation. With increasing level of castor oil in the dough, the dough become harder, more plastic and less sticky. The hardness of the biscuits decreased with the increase in the level of substitution of castor oil in the formulation. In terms of sensory evaluation, biscuits prepared with 56% castor oil were observed to most acceptable in terms of flavour, texture and overall acceptability as compared to biscuit prepared without castor oil and other low levels of castor oil. Laxative and fiber enriched biscuits thus prepared may help the ever-increasing number of consumers suffering from constipation. The FDA approves specific uses of castor oil in foods and pharmaceutical products. FDA has recognized that castor oil is Generally Recognized As Safe and Effective (GRASE) for over the counter (OTC) use as a laxative. However to be fully conclusive, a greater degree of scientific studies will be needed for any side effect of castor oil.

DISCLAIMER

The products used for this research are commonly and predominantly use products in our area of research and country. There is absolutely no conflict of interest between the authors and producers of the products because we do not intend to use these products as an avenue for any litigation but for the advancement of

knowledge. Also, the research was not funded by the producing company rather it was funded by personal efforts of the authors.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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