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Process optimization and shelf life studies of thermally processed bottle gourd *halwa*

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Abstract
Bottle gourd *halwa* is one of the Traditional Indian Dairy Product prepared from grated lauki or bottle gourd cooked with sugar, khoa, ghee and flavoured by spices like cardamom. The study was under taken to standardize process technology for manufacture of bottle gourd *halwa*. The *halwa* manufactured using standardized recipe was thermally processed in an autoclave for in-container sterilization at 121 °C temperatures for 15 min. and at 100 °C (hot water treatment) were selected. The stored bottle gourd *halwa* samples were evaluated for sensory attributes and analyzed for chemical characteristics and microbiological counts at an interval of 15 days. The pH was decreased but free fatty acids content and peroxide value were gradually increased in the *halwa* sterilized using both the treatments in all storage conditions. There was no adverse effect found on sensory attributes of the product during storage.

Keywords: bottle gourd, halwa, free fatty acid, thermal processing

Introduction
Indigenous dairy products have played an important role in socio-economic life of Indian people since time immemorial. India's market potential and current growth rate of Traditional Indian Dairy Products is unparalleled and all set to boom further under the technology of mass production. The operation flood programme, one of the world's largest and most successful integrated dairy development programme initiated in 1970 had led India to emerge as the world's largest producer of milk. Out of total milk production, about 50-55% of milk is used for the manufacture of different traditional dairy products. The manufacture of traditional milk products is mainly confined to the cottage scale in the non-organized sector [8, 14]. The traditional milk products in India have great significance as they account for over 90 % of all dairy products consumed in the country [2].

Traditional dairy products not only have established market in India but also have great export potential because of strong presence of Indian diaspora in many parts of world [15]. The market for traditional Indian milk products is very large, fast growing and is likely to increase at an annual growth rate of about 20% [15]. The small scale techniques used at present by different sweetmeat producers have several drawbacks such as non-uniform quality, limited shelf life of product and poor energy utilization. A variety of traditional milk products such as *khoa* and *khoa* based sweets, *paneer, shrikhand, rabri, kheer, halwa, basundi,* fermented products and many region specific traditional ethnic products are being manufactured in India. *Halwa* of various types are very popular in Indian market as sweetmeats with very rich in nutritional value. It is widely used in festivals, marriages, feasts, religious functions as well as in daily menus.

Bottle gourd is a good source of vitamin B-complex and ascorbic acid [15]. The production of bottle gourd varies considerably throughout the year. It can be preserved by extending the shelf life in processed form like juice and *halwa* [7, 10, 12]. Bottle gourd *halwa (Lauki ka halwa/ Doodhi halwa)* is a delicious sweet dish prepared from grated *lauki* or bottle gourd cooked with sugar, *khoa* and flavoured by spices like cardamom.

The various unit operations involved in preparation of bottle gourd *halwa* are shredding, cooking and desiccation with sugar and *khoa*. Keeping quality of the product is one of the essential requirements for the commercial manufacture of the product. It is expected that adoption of appropriate technology such as hot filling and sealing and in-container heat treatment of the product may improve the shelf-life of ready to eat product. The study was carried out to standardize of process technology for the manufacture of Bottle gourd *halwa* and optimization of processing conditions for in-container sterilization and storage of the product.

Materials and Method

The raw materials used for the preparation of bottle gourd *halwa* were bottle gourd, *khoa*, sugar, food grade colour and cardamom. Bottle gourd was procured from the local vegetable market of Anand. A white crystalline sugar of commercial grade free from impurities was purchased from the local market. *Khoa* and *ghee* were procured from the Department of Dairy Processing Operations (Anubhav Dairy), Anand Agricultural University, Anand. The average chemical composition of the *khoa* was 36.48% moisture, 10.91% protein, 19.0% fat, 29.8% lactose and 3.81% ash. Good quality cardamom and apple green colour of food grade quality were obtained from the market.

Standardization of recipe for the manufacture of bottle gourd *halwa*

Bottle gourd was thoroughly washed in the running tap water to remove surface adhering extraneous materials. The washed bottle gourd was peeled to remove thin skin from the surface. The top and bottom of bottle gourd was cut off and removed before shredding. The bottle gourd was then shredded. The shredded bottle gourd was roasted in *ghee* (~ 7 ml per kg shred) *in karahi* and cooked on low flame. The water liberated from the bottle gourd shred was adequate for cooking of the content. When the material became soft and cooked, sugar was added followed by addition of *khoa* with constant stirring on low flame till the final consistency was achieved. During last stage of cooking, edible permitted colour was added to impart very light greenish colour and cardamom powder was added as flavouring material.

The recipe which mainly consists of bottle gourd, *khoa*, sugar and *ghee* was optimized by adopting Response Surface Methodology (RSM). An advanced statistical software programme named Design Expert 8.0.3 was employed for optimizing level of major ingredients. The ranges of these ingredients were selected at varying levels with reference to weight of bottle gourd shred, *viz.* level of *khoa* (25 to 40%), sugar content (25 to 35%) and level of ghee (5 to 10%). The bottle gourd *halwa* prepared by combinations of various factors was evaluated by 9 point hedonic score card for sensory attributes.

Thermal Processing

The samples of optimized product were used for in container thermal treatment to enhance shelf life of the product. The bottle gourd *halwa* was hot filled and sealed in cans/tin containers of 200 g capacity for optimization of time and temperature of thermal processing. A stationary autoclave steam sterilizer (NOVA make, Microprocessor based digital display and controller) having facility of electrical heating and arrangement for the control of temperature and time was used for the experimental trials. Hot water system maintained at 100°C (considered as treatment 1 (T1)) was used for the treatment of the product while autoclave was used for 121 °C (considered as treatment 2 (T2)).

Storage Studies

The sample of product after thermal treatment were stored at BOD incubator (30 ± 02) °C and at refrigerated temperature (7 ± 2°C) for 0, 30, 45, 60, 75, and 90 days. The stored samples of bottle gourd *halwa* were evaluated for sensory attributes and analyzed for chemical characteristics and microbiological counts. Sensory evaluations were carried out in terms of colour and appearance, flavour, body and texture as well as overall acceptability of bottle gourd *halwa* using 9 point hedonic test. The chemical characteristics evaluated were free fatty acid, peroxide value and pH. The product was microbiologically analyzed.

Chemical and microbiological analysis

The peroxide value of stored products was determined by the method (iodometric method) as described by AOAC [4]. The pH of bottle gourd *halwa* was measured using Systronic digital pH meter, Model 335 as described by Franklin and Sharpe. [9] The method prescribed by Deeth [6]. was used to estimate the FFA content of bottle gourd *halwa.* The sterilized product was microbiologically analyzed in terms of coliform count using standard methodology during storage at an interval of 15 days [5].

Statistical Analysis

The data of sensory evaluation and storage study were analyzed statistically to know the best combination of the treatments applied. Factorial Completely Randomized Block Design described by Snedecor and Cochran [17] was adopted to analyze the data.

Results and Discussion

The major ingredients used in the preparation of bottle gourd *halwa* were shredded bottle gourd, sugar, *ghee* and *khoa.* The proportion of sugar, *ghee* and *khoa* in relation to bottle gourd shred was standardized by using Response Surface Methodology (RSM). It is reported that RSM is an effective tool for optimizing a variety of food processes [3, 13, 17]. The main advantage of RSM is to conduct relatively less number of experimental trials that provide sufficient information for statistically valid results.

Process optimization for the manufacture of *halwa* was carried out with the objective of determining the best possible combination(s) of different levels of factors viz. sugar (A) *ghee* (B) and *khoa* (C) that would lead to the most acceptable product in terms of sensory scores. Considering the parameters and their limits, the RSM suggested the one most suited solution. Suggested solution obtained for the preparation of *halwa* was 30% sugar, 6.83% *ghee* and 33.55% *khoa* of w/w of bottle gourd shred.

The final product was manufactured employing this suggested formulation and the actual results were obtained from the manufacture of bottle gourd *halwa*. The results were also validated statistically by 't' test. The values for 't' test being less than the table values, it is inferred that there is no significant (P>0.05) difference between the predicted and actual values of responses. The average composition of the experimental bottle gourd *halwa* was 16.85% moisture content, 7.16% protein, 13.84% fat, 60.25% carbohydrate and 1.90% ash.

Evaluation of bottle gourd *halwa* for chemical characteristics

The samples of bottle gourd *halwa* were analyzed for pH, free fatty acids (% oleic acid) and peroxide value (meq. O_2 per kg product) during storage.

Changes in pH during storage

The changes in pH values of samples of bottle gourd *halwa* prepared by two treatments and different time period are given in graphically depicted in Fig. 1 and Fig. 2. It is evident from the data that a gradual decrease in the pH was observed in *halwa* prepared using both the treatments irrespective of storage conditions. The pH of *halwa* (T1) stored at different

storage conditions (SC1, SC2 and SC3) was decreased from initial pH of 6.77 to 6.39, 6.22 and 6.19 after 90 days of storage respectively. Similarly, the pH of *halwa* (T2) stored at different storage conditions (SC1, SC2 and SC3) was decreased from initial pH of 6.77 to 6.38, 6.20 and 6.18 after 90 days of storage respectively. The decrease in pH may be attributed to development in acid formation during storage.

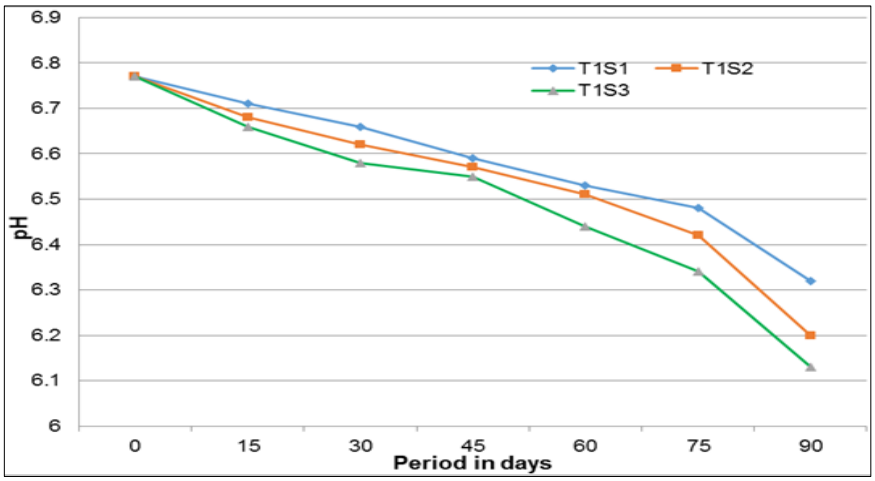

Fig 1: Effect of storage conditions on pH of bottle gourd *halwa* (Hot water treatment)

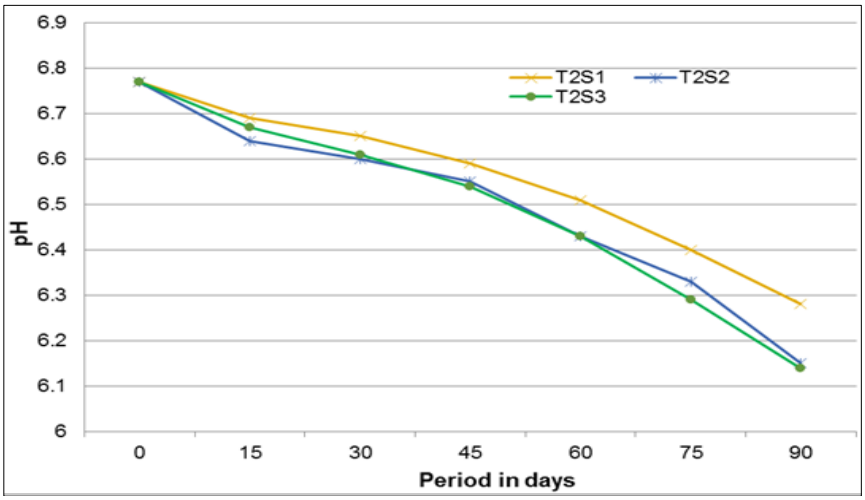

Fig 2: Effect of storage conditions on pH of bottle gourd *halwa* (Autoclave sterilization)

Changes in free fatty acids content during storage

The changes in free fatty acids content of samples of *halwa* are given in graphically depicted in Fig. 3 and Fig. 4. It was observed from the data that a gradual increase in free fatty acids content was observed in *halwa* prepared using both the treatments irrespective of storage conditions. This increase in FFA content could be attributed to hydrolysis of fat. A similar trend of increase in FFA content during storage was noticed in *burfi* by Tiwari [18]. Vijaykhader and Patel [19] also reported an increase in free fatty acids in *Peda* during storage at ambient temperature (25-29 ºC) using polyethylene bags of various densities.

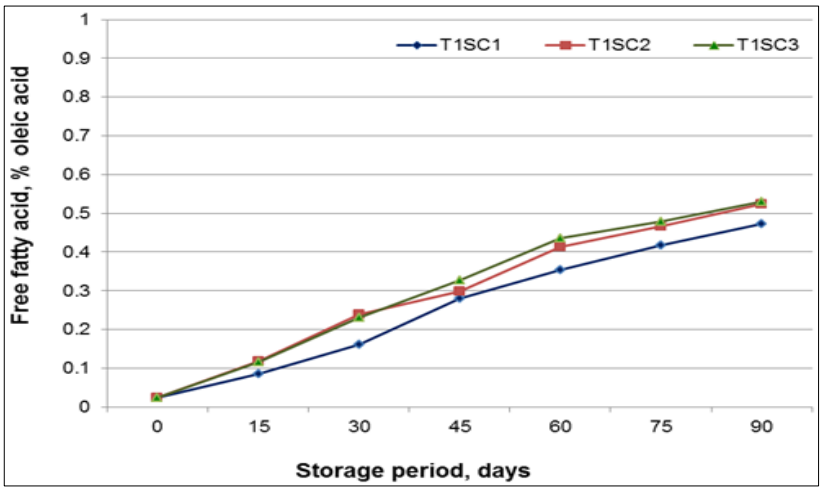

Fig 3: Changes in free fatty acids content of *halwa* during storage (Hot water treatment)

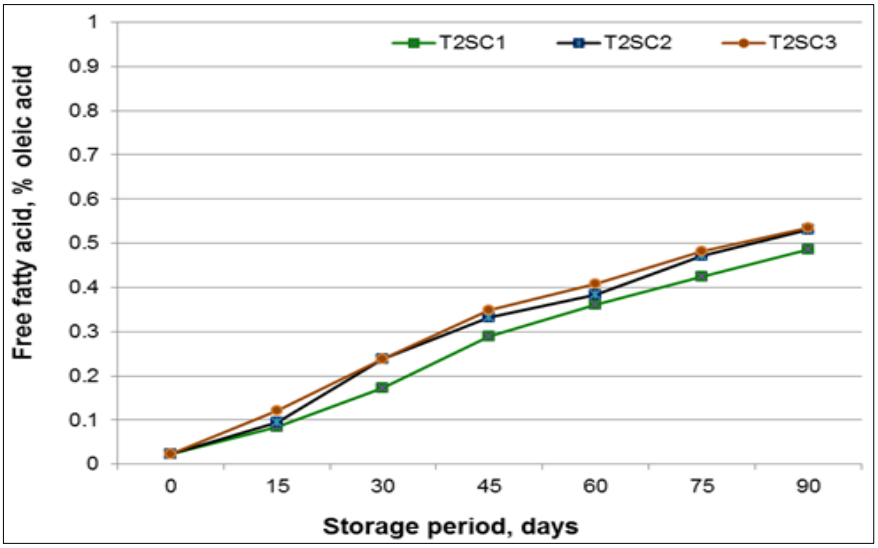

Fig 4: Changes in free fatty acids content of *halwa* during storage (Autoclave sterilization)

Changes in peroxide value during storage

Statistical analysis of the data indicated a gradual increase in peroxide value of *halwa* prepared using both the treatments irrespective of storage conditions (Fig. 5 and Fig. 6). The increase in peroxide value of these *halwa* during storage may be attributed to oxidative changes.

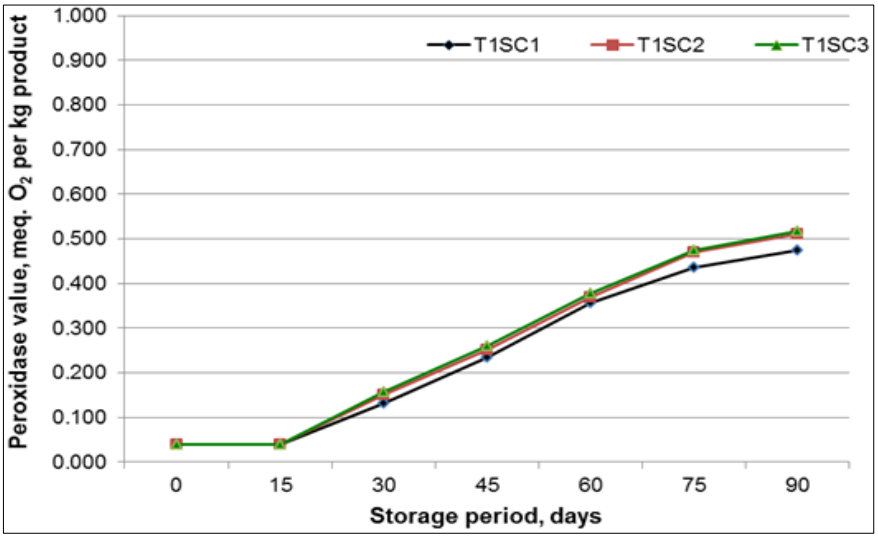

Fig 5: Effect of storage conditions on peroxide value (meq. O_2 per kg product) of bottle gourd *halwa* (Hot water treatment)

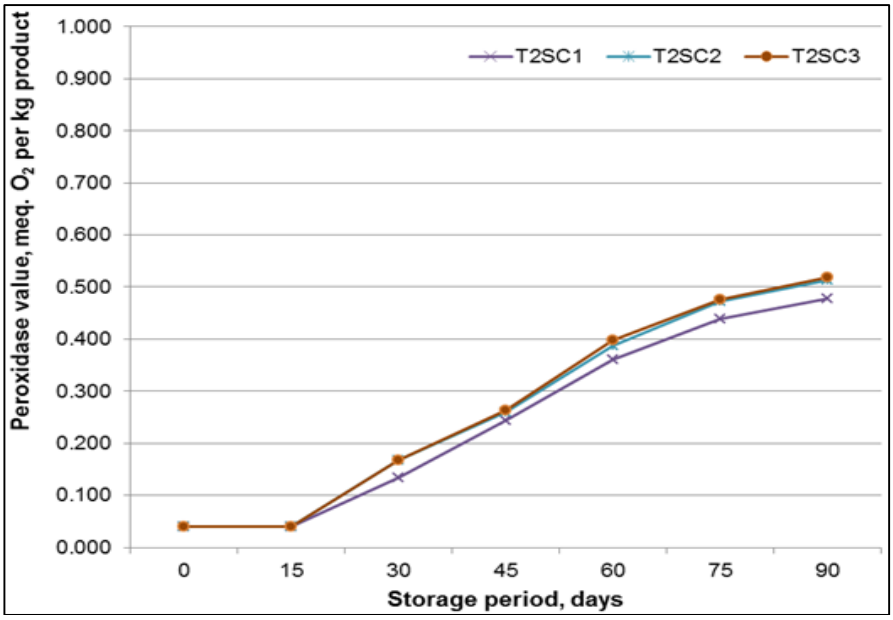

Fig 6: Effect of storage conditions on peroxide value (meq. O_2 per kg product) of bottle gourd *halwa* (Autoclave sterilization)

Conclusions

The optimized product was used for in-container sterilization to enhance shelf life of the product. It was revealed that a gradual decrease in the pH was observed in *halwa* sterilized using both the treatments irrespective of storage conditions. The pH of *halwa* (T1) stored at different storage conditions (SC1, SC2 and SC3) was decreased from initial pH of 6.77 to 6.39, 6.22 and 6.19 after 90 days of storage respectively. Similarly, the pH of *halwa* (T2) stored at different storage conditions (SC1, SC2 and SC3) was decreased from initial pH of 6.77 to 6.38, 6.20 and 6.18 after 90 days of storage respectively. A gradual increase in free fatty acids (FFA) content and peroxide value of in-container sterilized *halwa* was observed in *halwa* prepared using both the treatments irrespective of storage conditions. However, this level of FFA and peroxide did not show any adverse effect on sensory attributes of the product. The coliforms were found absent in all the sample of bottle gourd *halwa* initially as well as during storage.

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