International Food Research Journal 20(6): 3167-3170 (2013)
Journal homepage: *http://www.ifrj.upm.edu.my*

Development and evaluation of antioxidant activity of tomato based confectionary

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Article history

Received: 12 February 2013
Received in revised form: 8 August 2013
Accepted: 10 August 2013

Keywords

Fudge
Sensory quality
Antioxidant activity
Microbial count
Consumer acceptability

Abstract

Three variations of tomato fudge were prepared using tomato powder at different proportions with sugar, whole milk and honey and evaluated for sensory quality, antioxidant activity, microbial count and consumer acceptability. It was observed that the fudge prepared by using 1-3 g of tomato powder were having higher sensory scores while antioxidant activity was found highest in fudge having 5 g of tomato powder. Consumer acceptability was checked for the variation having highest scores for sensory characteristics i.e. fudge prepared by using 1 g of tomato powder and it was seen that the product was preferred by most of adults and children selected for the trial.

Introduction

Confectionary is essentially a sugar based industry and includes sugar boiled confectionaries, candies or sweets, chocolate confectionary and the traditional Indian sweetmeats. The confectionery products are highly popular among the children throughout the world due to their taste and flavor. Confectionary is recognized as an ingredient of a balanced diet and it has wide socio-economic and health impact. The conventional confectionary items are generally made from sugar, skim milk powder and other synthetic colors and flavors (Sakhale *et al.*, 2012). Soft candies such as fudge cadies are liked by all age groups especially children hence if the artificial color and flavor may be replaced by a natural ingredient, sweet fudge may become a good health boosting food. Tomatoes are important vegetable crop having number of health benefits due to the presence of ascorbic acid (vitamin C), folate, flavonoids and carotenoids (Leonardi *et al.*, 2000; Willcox *et al.*, 2003; Sesso *et al.*, 2004). Tomato, especially deep red fresh tomato is considered as the most important source of lycopene (~87 per cent). Lycopene is a powerful antioxidant which has been linked to reduced frequency and severity of several types of cancer and heart disease (Moselhi and Al Mslmani, 2008). Fruits and vegetables are considered as perishable products. Their shelf life can be increased by processing in to different value added products. Fruit and Vegetable powders are also been described as value added products obtained by drying to a certain moisture level. The characteristic flavours, colours, and nutrients as well as water binding properties of these powders make them an ideal addition to soups, sauces, marinades, baby foods, dips, extruded cereal products, fruit purees for confections, and fillings for frozen toaster snacks (Francis and Phelps, 2003; Pszczola, 2003). In the present investigation, the efforts have been made to incorporate tomato powder in place of artificial coloring and flavoring agent in the fudge and to evaluate its sensory and microbial parameters and antioxidant activity to reduce free radicals which will help to assess its functional benefit.

Materials and Methods

Fresh tomatoes (*Lycopersicon esculentum*) of var. 'Himsona' [Syngenta AG] fully red and ripe, firm, medium sized were taken and powder was prepared by pulping and drying in industrial type tray dryers at three different temperatures 60°C for 10 h at 53% Rh (Srivastava and Kulshreshtha, 2012). Sugar, butter, honey and milk were also purchased from the local market.

Preparation of fudge

Tomato fudge was prepared using the ingredients i.e. tomato powder, milk, sugar, butter and honey in following ratios (Table 1). In product formulation mixture design was used for raw materials. Tomato powder was used to introduce colour and suggestive of the flavor employed. Fat is added to candy to give it richness, desired texture and flavor. The sequential steps for the preparation of tomato fudge are in Figure 1. Prepared tomato fudge was filled in sealed aluminum foil sachets (pack size 100 g) and

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Table 1. Ingredients for making tomato fudge

Product code	Sugar (g)	Whole Milk (ml)	Tomato powder (g)	Honey (ml)	Butter (g)
TC-1	64	20	1	5	10
TC-2	64	15	3	5	13
TC-3	64	15	5	5	11

then packaged in the high-density polythene bags (thickness 80 microns) by double sealing and stored at -18°C in deep freezer.

Sensory evaluation

The sensory evaluation was performed by a trained / semi trained panel members. A 5-point hedonic scale ranging from 1 = dislike it very much to 5 = like it very much was used to evaluate acceptance from the TC-1, TC-2 and TC-3 samples for the attributes of color, appearance taste/flavor, texture and overall acceptability (Meilgaard *et al*., 1991).

Consumer acceptability trials

Best accepted variation of tomato fudge was subjected for consumer acceptability trials. The consumer acceptability was assessed by two consumer groups namely group-1 and group-2 comprising of 25 adults (20-25 yrs) and 25 children (6-12 yrs). 5-point and 3-point hedonic scales were used by group-1 and group-2, respectively. Each consumer was asked to consume samples and evaluate them for their overall acceptability on an evaluation card provided to them. For sample evaluation, a 5 g piece of tomato fudge was placed into paper plates coded with 3 digit random numbers. Samples consisting of TC-1, TC-2 and TC-3 (3 replicates of each) were served to each panelist (Resurreccion, 1998). Samples were presented to panelists in random order during the test day with water and paper napkins on a plastic tray. Panelists were instructed to consume the whole sample and rinse their mouths with water between samples to minimize any residual effect (Grosso and Resurreccion, 2002).

Microbial evaluation

Total bacterial count of samples was determined in using standard plate count (SPC) technique (APHA, 1984). Appropriate dilutions of the sample (1ml) were transferred aseptically to sterile petri plates in duplicate and mixed well with 10-15 ml of pre sterilized plate count agar at 45°C. After solidification plates were incubated at 37°C for 24-48 h in bacteriological incubator. Yeast and mould counts in fudge samples were determined according to APHA (1984) procedure by using potato dextrose agar (PDA) acidified with tartaric acid to pH 3.5 ± 0.1 before pouring. Ten to fifteen ml of medium was poured in petri plates containing 1 ml of sample dilution, mixed well, solidified and incubated for 18-24 h at 37°C in a Gallenkamp incubator (Model 1H-150, UK). All the analysis was done in triplicate. The total bacterial and yeast load after incubation was expressed as cfu/g after counting the colonies using the colony counter.

Measurement of antioxidant activity

The antioxidant activity of tomato fudge was estimated by the method of (Zhang and Hamauzu, 2004) with some modifications. 10 g of tomato fudge was homogenized with 15 ml of 80% methanol. The homogenate was filtered through four layers of cheesecloth and the residue was treated added with 15 ml of 80% methanol for two successive extractions. The filtrates were combined and centrifuged at 4000 rpm for 10 minutes. The supernatant of methanol extract was collected and diluted to various concentrations (1%, 2.5%, 5%, 7.5 and 10%) for measurement of total antioxidant activity 5% solution was found appropriate. Antioxidant activity was determined by using 1, 1- diphenyl -2- picryl-hydrazyl (DPPH) purchased from Sigma-Aldrich (India). All the reagents were of analytical grade. Solution of DPPH 0.1 mM in methanol was prepared and 4 ml of this solution was treated with 0.2 ml of diluted extract. A control was treated with 0.2 ml of distilled water instead of the extract. The mixture was left to stand for 60 minute before the decrease in absorbance at 517nm was measured by UV-vis spectrophotometer (MultiSpec-1501, Shimadzu, Japan). Antioxidant activity was expressed as the percentage of DPPH radical decrease using the equation. All the analysis was performed in triplicates.

$$AA\ (\%) = [(A_{sample} - A_{sample\ blank})/A_{control}] \times 100$$

$A_{control}$ is the absorbance of the control (DPPH solution without the sample). A_{sample} is the absorbance of the sample (DPPH solution with the sample). A sample blank is the absorbance of the sample solution without DPPH. Single variable factorial design was used to conduct all the experiments.

Results and Discussion

Sensory evaluation and consumer acceptability

Sensory evaluation was performed to assess the sensory attributes of the product and its acceptability. Highest score for colour was obtained by TC-1 followed by TC-2 and TC-3. In case of appearance, flavor, texture and overall acceptability there was no significant difference between TC-1 and TC-2 but TC-3 showed significant difference when compared with all the other variations of fudge. The highest

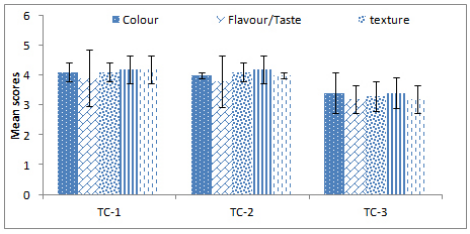

Figure 1 Sensory characteristics of tomato fudge

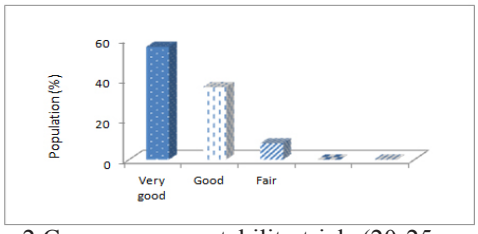

Figure 2 Consumer acceptability trials (20-25 yrs.) of tomato fudge

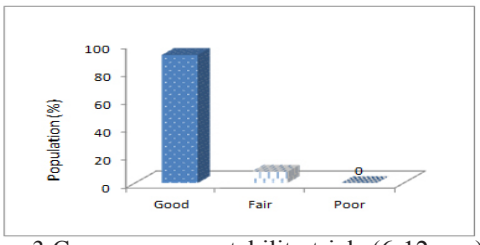

Figure 3 Consumer acceptability trials (6-12 yrs.) of tomato fudge

score for overall acceptability was obtained by TC-1 followed by TC-2 and TC-3 (Figure 1). Hence, the level of 1-3 g of tomato powder can be incorporated for the preparation of tomato fudge which not only provide it significant taste but made nutritionally rich also.

The primary purpose of consumer testing is to assess the personal response by current and potential customers of a product. Consumer acceptability was evaluated for the best acceptable variation of tomato fudge i.e. TC-1. Almost half of the adult consumers from group-1 i.e. 56 per cent preferred the preparation very much while liked moderately by the rest 36 per cent adults. Only 8 per cent of people from group-1 liked it slightly. It is clear from the results that most of the children i.e. 92 per cent liked tomato fudge very much while 8 percent preferred it moderately as shown in the Figures 2 and 3.

Microbial evaluation

The results of microbiological analysis of all the three variations tomato fudge has been presented in Table. 2. Total viable count of tomato fudge were 3.0 x 10^1, 3.0 x 10^1 and 2 x 10^1, respectively. Yeast and mould count in case of tomato fudge, was found lowest i.e. 0.5 x 10^1 cfu/g respectively. The overall concentration of Total Viable counts was found lower in all types of products when compared to public

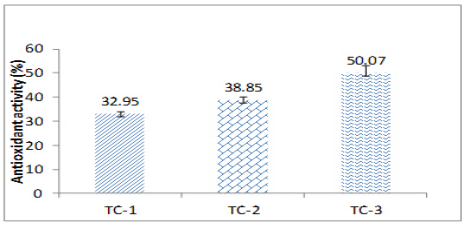

Figure 4 Antioxidant activity of tomato fudge

health leadership society guidelines (PHLS) for confectionary products based on fruits and vegetables (Gilbert *et al*., 2012).

Antioxidant activity

The antioxidant activity was tested using the DPPH radical. The antioxidant activities of TC-1, TC-2 and TC-3 were found, 32.95, 38.85 and 50.07 per cent for TC1, TC-2 and TC-3, respectively (Figure 4). The antioxidant activity of TC-3 was found highest while for TC-1 found lowest. The presence of high ascorbic acid and lycopene content may be the possible reason of the higher antioxidant activity of TC-3 than the two other variations namely TC-1 and TC-2. Lycopene is the chief antioxidant present in tomato products (Holden *et al*., 1999). The presence of lycopene in tomato powder is the main reason of the high antioxidant activity of formulated products (Di Mascio *et al*., 1989). However ascorbic acid is also present in tomatoes which is a potent antioxidant and may contribute to the reduction of DPPH radicle, however, in this case cooking at 240°F for the formulation of tomato fudge may degrade most of the ascorbic acid content as it is highly susceptible to increase in temperature (Bamji *et al*., 2010). Lycopene also tend to degrade with increasing time and temperature (Srivastava and Srivastava, 2012) but its degradation rate is much slower than ascorbic acid which rapidly degrades during cooking. Less than 10% loss of lycopene has been reported during the production of semidried tomato at 48°C (Toor and Savage, 2006). Relative to raw carrots 40 fold increase in the level of 9-cis-lycopene and slightly higher 15-cis-lycopene was found after heat treatment of carrot homogenates at 120°C for 2 hours and above. Hence, the presence of lycopene is essentially the contributory factor towards the higher antioxidant activities of the formulated products.

Conclusion

Three variations of tomato fudge namely TC-1, TC-2 and TC-3 were tested for sensory quality, consumer acceptability, antioxidant activity and microbial load determination. Among the three samples TC-1 was found best acceptable based on

sensory scores. Sensory acceptability of the next variation TC-2 was also comparable to TC-1. Hence, these two variations of tomato fudge consisting 1 and 3 g of tomato powder, respectively, are appropriate for large scale production. As far as the third variation TC-3 is concerned, however, it possessed the highest amount of tomato powder and the antioxidant activity was highest for this variation, the significantly lower sensory scores ($p = 0.5$) suggested that the incorporation of tomato powder more than the level of 3 g is not much acceptable. Microbiological load determination data revealed that total viable count in all the three variation is below than the standard for confectionary products as recommended in PHLS guidelines (Gilbert *et al*., 2000) which shows the appropriate quality of the products using the experimental processing conditions.

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