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Effects of Pre-Heating and Concentration Temperatures on Microbial and Sensory Quality of Semi Concentrated Tomato (*Solanum Lycopersicum*) Paste

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Abstract

Fresh tomato is one of the fruits with a short shelf life. The purpose of this study was to evaluate the effects of pre-heating and concentration temperatures on the microbiological and sensory quality of semi processed tomato paste. Breaking temperatures of 60□C, 70□C and 90□C for 7minutes and concentration temperatures of 8□C and 90□C were used to preparesemi tomato paste of 13 degree brix of total mesophilic aerobic plate counts and fungal counts and sensory quality were determined following standard methods. Increasing breaking temperature and concentration temperatures significantly ($p<0.05$) reduce microbial loads. Processing conditions have a great influence on the overall quality of the final product. The breaking process at 70□C and concentrating at 80□C shown good with higher overall sensory acceptability with lower number of microbial load with acceptable range. Therefore, breaking at 70□C and concentrating at 80□C can be adopted for commercial production of tomato paste.

Keywords: Tomato paste; Breaking; Concentration; Microbial and Sensory quality

Introduction

Tomato (*Lycopersicone sculentum*) is an important vegetable crop grown in many countries across the world for fresh market and a multiple processed forms. It is considered as an important cash generating crop for smallholders and medium scale commercial farmers and provides employment opportunity in the production and processing industries. Tomato consumption also makes significant contributions to human nutrition throughout the world. Fresh tomato has a limited storage life 2-3 weeks under ambient temperature and cannot be stored over extended periods. To minimize after harvest losses, tomato is processed in the forms of paste, juice, ketchup, sauce and purée. According to Arabhossein (2007), tomato paste comprises of crushed tomatoes before or after skin and seeds removal. The food safety and shelf life of tomato and tomato products are depend on the presence or absence of microorganisms. The expected microbes in tomato products are spores forming and no spore forming acidophilicbacteria, yeasts and molds. Destruction and survival of these microorganisms depends on the thermal treatment applied during processing. According to *Bacillus coagulans*, a non-pathogenic and facultative anaerobic spore-forming, acid tolerant bacteria which grows well in foods from pH 4.0 to 4.5 at ambient temperature is frequently isolated from spoiled canned vegetables acidified to pH 4.0 to 4.5. *Bacillus coagulans* is considered the primary cause of important spoilage in thermally processed tomatoes and tomato products.

Thermal processing is the most common and effective method for inactivation of microorganisms and extending the shelf-life of tomato products. Most published data related to the inactivation of *B. Coagulans* spores in food are based on moderate heat treatment and/or hurdling effect with high pressure. Since tomato paste is the main ingredient in the final products, maintaining the quality of the paste is crucial for the tomato processing industry. The characteristics quality factor of tomato paste depends on the quality of starting raw materials (variety and ripening stages). Processing conditions (process design, time, and temperature and process pressure), storage time and conditions. These factors introduce great variation in the quality of the paste. These variations pose difficulties in achieving a consistent paste quality during production. As a quality control routine for pastes included: Color, flavor, texture and overall sensory acceptability.

Materials and Methods

Description of the study area

This study was conducted in Food microbiology and sensory laboratory at the School of Nutrition Food Science and Technology, college of Agriculture, Hawassa University, Hawassa Ethiopia.

Experimental design and treatments

A factorial experimental design of two factors (3 of levels breaking and 2 of levels concentration) were used to determine effect on physicochemical, microbial and sensorial quality of semi concentrated tomto paste. Cold, Normal and Hot break at 60 C, 70 C and 90°C were used. The concentration process was done at 80 and 90°C. Concentration was carried out until a TSS content of ≥ 13% conventionally. This experiment has six treatment combination, and all the parameters (quality indexes) were done in triplicate. The treatments were CB-C1 (Cold beak at 60 C and concentrated at08 C)-T1; CB-C2 (Cold beak at 60 C and concentrated at 90-)C T2; NB-C1 (normal break at 70 C and concentrated at 80;3T-)C NB-C2 (normal break at 70 C and concentrated at 90 C)–T4; HB-C1(hot break at 90 C and and concentrated at 80 C)-T5 and HB-C2

(hot break at 90 C and and concentrated at 90 C)-T6. Fully ripe tomato fruits Roma variety were purchased from Jitu Horticultural Center, Hawassa, Ethiopia.

Sample preparation

Sorting and cleaning: The parameter used for tomato sorting is color and physical state of fruits. Therefore, the ripe tomato fruits of uniform size were selected and they have been sorted out to eliminate bruised, punctured and damaged one.

Washing is a critical control step in the processing of tomato products with a low microbial count. The ripe tomato sample was washed with potable water to remove dirt, mold, insects, and other contaminants.

The sorted tomatoes were then washed under potable water. The cleaned tomatoes were individually cut into four quarters and the seed and pulp removed manually by using clean knife. The seed and peel removed pulp further copped and crashed by fruit juicer.

Breaking: The seed and peel removed pulp further copped and crashed by house hold juicer then three break temperatures were used as cold break at 60 C, normal break at 70 C and hot break at 90 C for the action natural enzymes for 7 minutes to all the breaking temperatures.

Evaporation: After sorting and effective cleaning, the tomato paste entered in the evaporation process.

The tomato paste was evaporated at 80 C and 90 °C to achieve 13 Bx of total soluble solids concentration in conventional techniques by kitchen sauce pan at atmospheric pressure for 2.5 to 3 hours. This is done after the respected breaking.

Pasteurization: After evaporation, the tomato paste was filled in previously sterile screw sample jars and pasteurized in water bath at 100°C for 14 minutes, in atmospheric pressure.

The pasteurized tomato paste was cooled and stored at ambient temperature. This process was done after concentration. The tomato paste was prepared as illustrated in Figure 1.

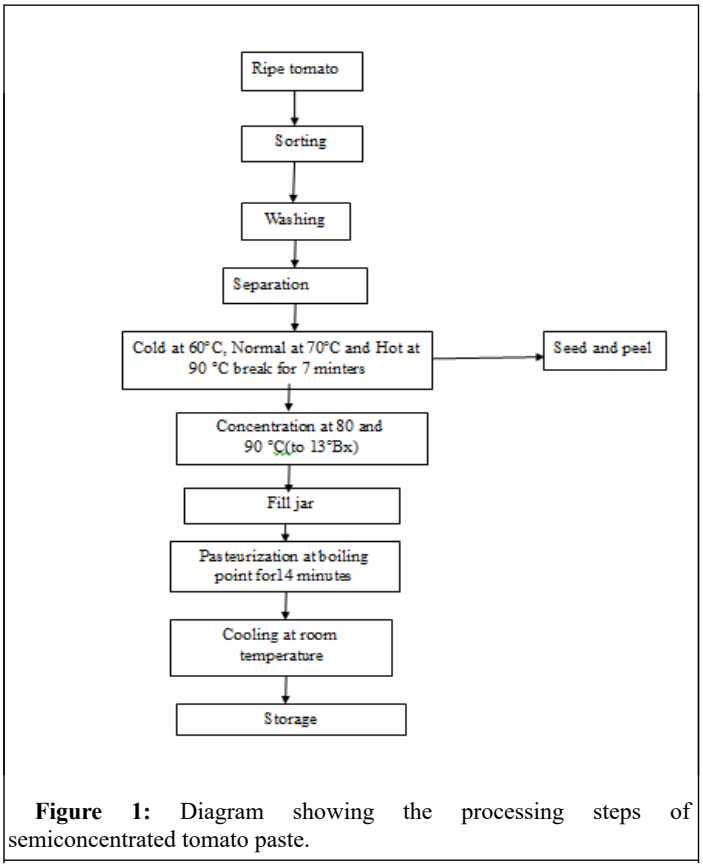

Figure 1: Diagram showing the processing steps of semiconcentrated tomato paste.

Analyses of samples

The processed semi concentrated tomato paste were characterized for the physicochemical (Total soluble solids, pH, titratable acidity, viscosity, vitamin C and lycopene content), microbial quality (Total mesophilic countand yeast and mold Counts) and sensorial quality were described below.

Microbiological analysis of the tomato paste: Ten (10) mL from each type of tomato pulp samples were aseptically taken and blended with 90 mL of 0.1% sterile buffered peptone water and homogenized with stomacher for 2 minutes. Using 9 mL peptone water test tubes. 10-2, 10-3, 10-4 and 10-5 serial dilutions were prepared. Using spread plate technique, 0.1 mL from appropriate dilution wasinoculated onto suitable culture media for the cultivation of microbes that was analysed in this study.

Total mesophilic aerobic plate count (TMAC): Using spread plate technique, a 0.1 mL of sample from the serial dilutions of 10-1, 10-3 and 10-5, were taken and plated on Plate Count Agar (Oxoid, Basingstoke, Hampshire, England). The plates were incubated for 48 hours at 35°C. Colonies in the range of 30-300 were counted and used to calculate the microbial load in cfu/ml.

Yeast and mold count (YMC): Using spread plate technique, 0.1 ml of sample from the serial dilutions of 10-1, 10-3 and 10-5, were taken and plated on Yeast glucose chloroamphenicol agar (Oxoid, Basingstoke, Hampshire, England). The plates were incubated for 72 hours at 28°C. Colonies in the range of 30-300 were counted and used to calculate the microbial load in log cfu/mL using the equation below. The result was reported in log cfu/mL.

Sensory quality and acceptability of tomato paste: The effect of breaking and concentration temperature on sensory acceptability was evaluated by using an untrained panel (n =30) comprising of students and Staff of Hawassa University, as well as other people from surrounding areas. A 7-point hedonic scale (1='Strongly disliked'; 2='Moderately disliked'; 3='Slightly disliked'; 4='Indifferent'; 5='Slightly liked'; 6 ='Moderately liked', and 7='Strongly liked') was used to score the level of acceptance of the different sensory attributes of tomato paste (color, flavor taste, appearance and overall acceptability). The tomato paste samples were presented on identical serving trays and coded with three digit random numbers. The order of sample presentation was randomized. Potable water held at room temperature was served by the panelists for cleansing the palate before and between testing of the tomato paste samples. An empty beaker was provided for the purposes of expectoration.

Data analysis

Data were represented as means ± standard deviations of triplicates. All collected data were subjected to analysis by using one way of Analysis of Variance (ANOVA) using SAS software program (version 20). Mean separations was done using Least Significant Difference (LSD) at $p< 0.05$.

Results and Discussion

Breaking and concentration process effect on the microbial quality of tomato paste

In (Table 1) the effect of breaking and concentration temperature on the microbial load of tomato pastes (total mesophilic count and yeasts and molds) can be observed. All tomato paste samples resulted in reductions of the initial microbial load by 1 log cycle. Such reduction in bacterial count of the investigated tomato paste was mainly due to the heat treatment and subsequently, the possible reduction in water activity. HB-C2(T6) shown the lowest total aerobic mesophillic count (1.38 log cfu/ml).The total yeast and mold count was abscent in T3,T4,T5 and T6.However, the control fresh tomato juice sample has higher total aerobic mesophillic count (2.80 log cfu/ml) and yeast and mold counts (2.10 log cfu/ml).The control sample shown higher contamination and growth of microbial flora. The results obtained in this study were complied with the standards of Ethiopian Standard Agency (ESA) for microbial level of food. All the total plate count results of tomato paste samples were below the acceptable limit (1.38-2.38 log cfu/ml). However, the control sample is not in acceptable limit. The total yeast and mold count in the present study was in acceptable limit (1-2.18 log cfu/ml).

Treatments	Microbial load	
	TAMC (log cfu/ml)	YMC (log cfu/ml)
CB-C1(T1)	2.01 ± 0.09b	1.26 ± 0.22b
CB-C2(T2)	1.90 ± 0.09b	1.34 ± 0.30b
NB-C1(T3)	1.40 ± 0.21c	Abscent
NB-C2(T4)	1.38 ± 0.04c	Abscent
HB-C1(T5)	1.00 ± 0.02d	Abscent
HB-C2 (T6)	1.00 ± 0.07d	Abscent
Control (fresh tomato juice)	2.80 ± 0.11a	2.1 ± 0.03a
Acceptable Limit	1.38-2.38	1.0-2.18

Table 1: Breaking and concentration process effect on the microbial quality of tomato paste Values are means ± standard deviations of the triplicates determinations. Values in the same column with same superscripts (a, b, c) are not significantly different at ($P<0.05$).

Sensory quality and acceptability of semi concentrated tomato paste

The score for sensory quality and acceptability of semi concentrated tomato pastes produced under cold, normal and hot break thermal treatment and concentration at 80 C and 90°Care presented in Table 2. The control sample (fresh tomato juice) scored the highest sensory value in color (6.11) and followed by at T5(5.10)and T6(5.01) is the lower value in color were observed among the treatments. In food products, especially fruit based ones, the consumer often assesses the initial quality by their color and appearance; hence these attributes are the primary indicators of perceived quality. All the six treatments from T1 to T6 resulted in sensory test score for the taste in the range of 6.20 to 6.55.However,control sample seemed to be the least preferred by the test panel for test for presenting an lower mean score (4.22); while the mean score of the samples flavor was in acceptable range (5.38-5.77).The overall liking of samples ranged from (slightly liked) to 6 (moderately liked),and sample T3 (6.22) and T4(6.15) showed the highest mean score. Overall liking was strongly correlated to the taste of the samples .These findings indicate that the tomato paste produced at cold, normal and hot breaking process and concentrated at 80 C and 90°C present suitable sensory scores and high acceptance.

The quality of process tomato products is highly variable. Processing conditions have a great influence on the overall quality of the final product. Processing at lower temperature allows better retention of color and aroma. However; the product may be separate on standing. On the other hand, high temperature processing gives a more stable product with high consistency but alter the color and aroma of the products.

Traetment	Color	Flavor	Tate	Apperance	Overall acceptability
CB-C1 (T1)	5.98 ± 0.22b	5.55 ± 0.20b	6.22 ± 0.19a	5.98 ± 0.26b	5.90 ± 0.12b
CB-C2(T2)	5.96 ± 0.14b	5.53 ± 0.12b	6.20 ± 0.17a	5.96 ± 0.41b	5.98 ± 0.23b
NB-C1(T3)	5.92 ± 0.08b	5.77 ± 0,31a	6.50 ± 0.11a	6.15 ± 0.21a	6.22 ± 0.32a
NB-C2(T4)	5.90 ± 0.14b	5.72 ± 0.22a	6.55 ± 0.20a	6.16 ± 0.15a	6.15 ± 0.40a
HB-C1 (T5)	5.10 ± 0.09c	5.41 ± 0.13c	6.43 ± 0.12a	6.20 ± 0.16a	5.88 ± 0.51b
HB-C2(T6)	5.01 ± 0.28c	5.38 ± 0.14c	6.40 ± 0.23a	6.22 ± 0.32a	5.79 ± 0.49b
Control	6.11 ± 0.13a	5.09 ± 0.12d	4.22 ± 0.29b	5.21 ± 0.29c	5.01 ± 0.12c

Table 2: Sensory quality and acceptability of tomato pastes.

Conclusion

The effect of preheating (breaking) and concentration process on microbiological and sensory quality were analysed and the following conclusions were made. The microbial analysis results of tomato paste for detection of total aerobic mesophilic count and yeast and mold count shown that the tomato paste samples in all treatments were in acceptable range of microbial load.

Processing conditions have a great influence on the overall quality of the final product. Sample breaking at 70°C and concentrating at 80°C shown higher overall sensory acceptability. The breaking process at 70°C and concentrating at 80°C shown good with higher overall sensory acceptability with lower number of microbial load with acceptable range.

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