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EFFECT OF MOISTURE CONTENT ON THE PRESERVATION OF CHEMICALLY PRETREATED CANNED TOMATO PUREE

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Abstract
The effect of moisture content on the preservation of chemically pretreated and canned tomato puree was determined. Three samples labeled A, B, C concentrated to different solid content levels via evaporation, and preserved using 60 mg of sodium meta-bisulphate were investigated. Results revealed that sample 'C' that was at 90.63% moisture content and 9.37% tomato solids gave the best performance with no bacterium growth and no color (bright red) change. There was no decrease in the weight of sample 'C' throughout the eight months of storage. Samples 'A' at 85.20% moisture content and 'B' at 88.57% moisture content, showed significant changes in weight of tomato puree at 1% level of significance. Although no bacterium growth was observed in samples 'A' and 'B', the puree samples underwent color change from bright red to dark brown. The pH for samples 'A' and 'B' ranged from 5.0 to 5.4 while for sample 'C' it ranged from 4.2 to 4.45. The average ambient temperature during the study was 30.5^{o}C.

Keywords: Tomato purees, moisture content, bacteria count, color change, preservation

1. Introduction

Tomatoes are fruits of the plant *Lycopersicon esculentum* and are one of the most widely grown vegetables. They are consumed fresh or as processed products such as canned whole tomatoes, tomato juice, tomato puree, tomato paste, ketchup and chili sauce. Unfortunately, the fruit is highly perishable in its fresh form and short-seasoned due to its storage difficulties.

Tomatoes are produce in appreciable tonnage in the Northern part of Nigeria. For instance, investigation carried out by Agbonifor (1974) showed that 88.2 tonnes per year of tomato were produced in the six villages investigated. This huge amount of tomato needs to be properly managed in order to prevent wastages.

However, due to their unique importance and volume of production, a form of storage is required to prevent or at least delay enzymatic and/or microbial changes in it to make it available at some future time (Brownsell *et al*., 1989).

Food preservation methods refer specifically to the processing techniques that are normally used to keep food from spoiling. Spoiling is any change that makes food unfit for consumption, and include chemical and physical changes such as bruising and browning, infestation by insects or other pests or microbial attack such as bacteria, yeasts and moulds growth. Some preservation techniques destroy enzymes and proteins that are responsible for the chemical and physical changes that naturally occur after harvesting. Food preservation techniques also help to eliminate the moisture or temperature conditions that are favorable for the growth of microorganisms. The action of microorganisms (as they grow) on foods can result in food borne illness, also the microorganisms breakdown the foods producing unpleasant changes in taste, texture and appearance.

The basic forms of food preservation techniques include canning, sun drying and dehydration, smoking, curing and fermentation, freezing and refrigeration, use of chemical additives and packaging (Ihekonronye and Ngoddy, 1985). It was thought that a combination of canning and chemical preservation techniques could be used to establish a status for tomato preservation.

Canning preservation techniques involves killing of bacteria that would cause decay and then sealing the food in a closed container into which other microorganism cannot penetrate (Magnus, 1981). On the other hand, chemical preservation technique involves addition of chemicals intentionally to foods in order to make them look and taste better, maintain or improve nutritive value and to retard food poisoning by growth of micro-organisms.

The National Agricultural Extension and Research Liaison Services of Ahmadu Bello University, Zaria has carried out a lot of work on tomato preservation (Orewa, 1978) but the attention has mainly focused on solar drying and domestic freezing. These methods have their limitations ranging from exposure to rainfall and inadequate space to cope with the capacity of tomatoes to be processed and preserved. To combat these problems, a joint venture between Cadbury Nigeria Limited and Kaduna State government to develop an agro-industry, was conceived but this failed because of the government and farmers' attitude towards the project (Agbonifor, 1974).

In this study, a combination of two well-known preservation techniques namely canning and chemical additives was used to investigate the effect of initial moisture content on the preservation of tomato puree. Observations and data collected include: bacterial counts, pH, color and volumes of tomato puree in each of three samples ('A', 'B' and 'C') investigated. In addition, a test of significance for weights of tomato puree at 0.02% significant level using t-distribution was conducted.

2. Development of a status for tomato preservation

The procedure developed for processing tomato fruit into tomato puree involved two well-known preservation techniques namely canning and chemical treatment. Tomato puree consists of tomatoes that have been grinded, cooked briefly and strained, resulting in a thick liquid (Ochef, 2006). Pure tomato juice is then concentrated under vacuum to obtain the tomato puree after a pretreatment process (Ihekonronye and Ngoddy, 1985; Ochef, 2006).

The procedure consists of the following unit operations: pretreatment (this includes washing, sorting, removing of seed and skin from sound fully ripe tomato), grinding, evaporation, mixing and sealing/packaging. These processes can be integrated and used to process tomato juice into tomato puree in a continuous operation by applying the appropriate chemical engineering principles shown in the process block diagram presented in Figure 1.

The developed procedure was validated using a set of experiments. Necessary parameters required to scale-up this bench scale study into a pilot plant were also obtained.

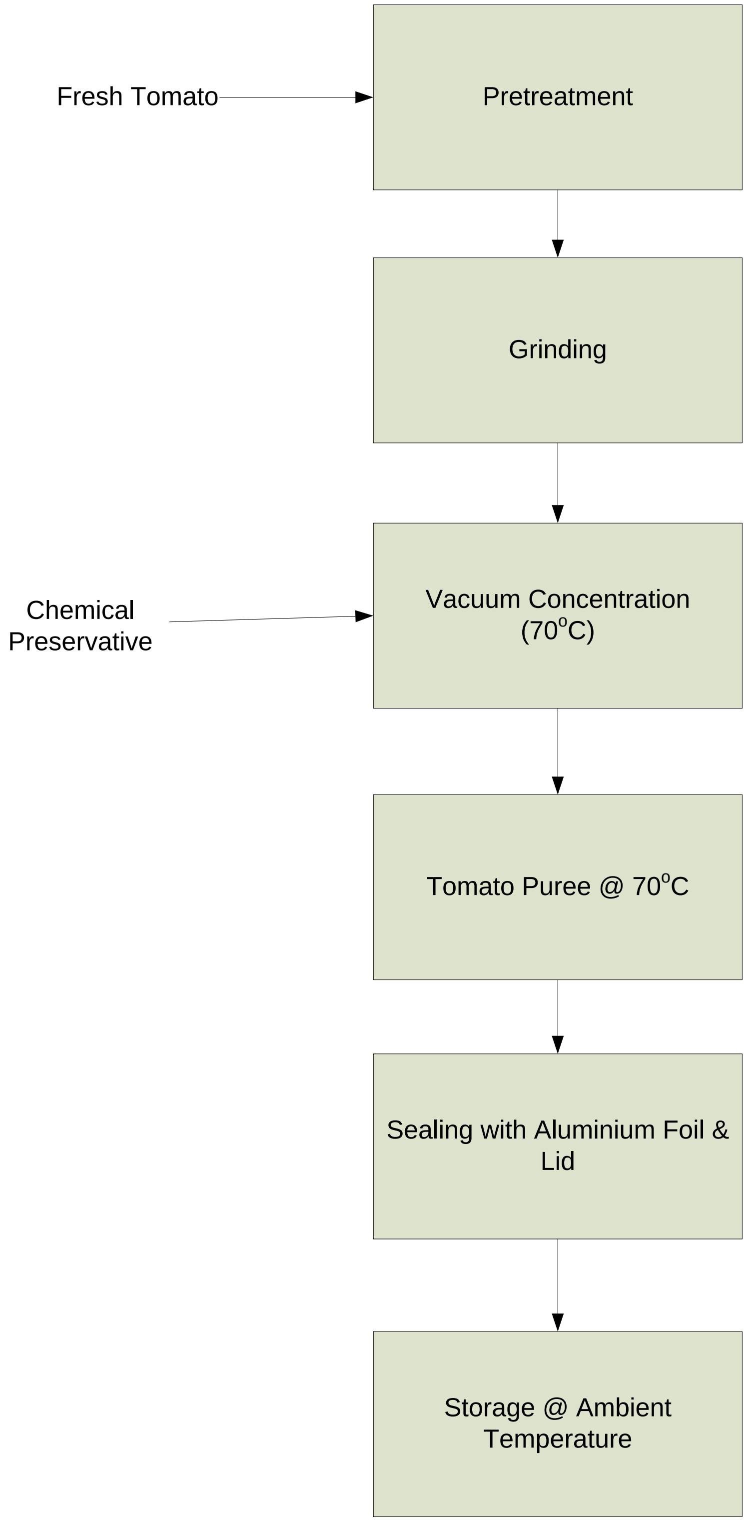

Figure 1: Flow Sheet for processing of tomato juice into tomato puree using a combination of canning and chemical preservation techniques

3. Materials and methods

Fresh tomato fruits of the same variety *ROMA VF* were washed thoroughly, de-stoned, de-skinned and ground into juice. 200 g each of the ground tomatoes was weighed into three different cylindrical containers of 244.3 cm^3 capacities. Tomato juice in each of the cans was sterilized at 100^oC using the method of Hersom and Hulland, (1980). It was then maintained at 70^oC on a hot plate in a vacuum chamber to concentrate the tomato juice into tomato puree. Different amounts of moisture were removed from each of the three cans by weighing each of samples prior to vacuum evaporation and sterilization and re-weighing these samples after vacuum evaporation and finding the difference to determine the percentage by weight of moisture evaporated from each container. Sample "A" had 52.5% of its initial weight reduced as evaporated water, which left its remaining weight at 95 g consisting of solids and the remaining moisture. Similarly, samples "B" and "C" had 38.5% and 25.0% of their initial weights respectively reduced as evaporated water leaving their remaining weights at 122.40 g and 150 g consisting of solids and remaining moisture. 60 mg of sodium meta-bisulphite were stirred into each of the cans and sealed with aluminium foil. The containers were then covered with lids under vacuum in order to eliminate air and the contents were heated to 70^oC and maintained at this temperature for 20 minutes.

The containers were kept in the laboratory cupboard at ambient temperature. About 270 mg of each sample was collected at a specified time in the day, for bacterial counts and pH analysis. Collections were carried out for the following periods; 1 day, 2 days, 3 days, 4 days, 5 days, 6 days, 1 week, 2 weeks, 3 weeks, 1 month, 3 months, 6 months and 8 months respectively. These samples were collected aseptically and inoculated stored in different Petri-dishes containing nutrient agar and peptum water. The inoculated samples were incubated for twenty-four hours to facilitate bacterial growth before the bacterial were counted and recorded using the colony counter.

The volume of tomato puree in each container was measured for the following periods: 1 day, 2 days, 3 days, 4 days, 5 days, 6 days, 1 week, 2 weeks, 3 weeks, 1 month, 3 months, 6 months and 8 months respectively. The volumes were estimated by multiplying the depth of tomato puree in each container by the area of the container. The depth of tomato puree in each container was estimated by dipping a sterilized rod (1 cm in diameter) into each container and measuring the level covered by the content with a ruler. In addition, pH of these samples was monitored throughout the duration of the study.

4 Results and discussion

4.1 Solid content in tomato puree

The percentage by weight of solids contained in samples 'A', 'B', and 'C' were computed to be 14.80%, 11.43% and 9.37% respectively. These solids contents were in agreement with literature values (Ihekonronye and Ngoddy, 1985).

4.2 Bacteria count on tomato puree

The results shown in Table 1 indicate that there was no bacterium in the three samples investigated during the eight months of storage. Changes in color of the tomato purees were observed in samples 'A' and 'B' between the 90th and 180th days. For instance, sample 'A', changed from bright red to light brown after the 90th day and later to dark brown at the end of the 180th day, while that of sample 'B' changed from bright red to dark brown at the end of 180th day. Changes in color of samples 'A' and 'B' can be attributed to action of fungi on these samples because of the unfavorable pH regime.

Table 1: Bacterial counts and color of tomato puree at different moisture content level stored over a period of eight months

	Sample "A"		Sample "B"		Sample "C"	
Time,days	Bacterial count	Color	Bacterial count	color	Bacterial count	color
1	nil	bright red	nil	bright red	nil	bright red
2	nil	bright red	nil	bright red	nil	bright red
3	nil	bright red	nil	bright red	nil	bright red
4	nil	bright red	nil	bright red	nil	bright red
5	nil	bright red	nil	bright red	nil	bright red
6	nil	bright red	nil	bright red	nil	bright red
7	nil	bright red	nil	bright red	nil	bright red
30	nil	bright red	nil	bright red	nil	bright red
90	nil	light brown	nil	bright red	nil	bright red
180	nil	dark brown	nil	dark brown	nil	bright red
240	nil	dark brown	nil	dark brown	nil	bright red

4.3 pH of tomato puree

The pH for samples 'A' and 'B' ranged between 5.0 and 5.4 during the period of investigation. This pH range is favorable for the growth of fungi and resistance to the growth of bacteria (Magnus, 1981). In addition, yeast (fungi) is able to grow freely either with or without air and are able to withstand substrates with high salt concentrations. This can be due to the incompatibility between the moisture content level in the processed samples 'A' and 'B' and stabilizing chemical (sodium meta-bisulphite). On the other hand, the pH for sample ‘C’ ranged between 4.2 and 4.45 during the investigation, this pH range is within the maximum of 4.5 required for tomato puree (Products, 2006). In addition, sample ‘C’ retained its bright red color throughout the 240-days of storage. This can be due to the favorable pH regime and the compatibility between moisture content level in the processed sample ‘C’ and the stabilizing chemical (sodium meta-bisulphite).

Table 2 shows the changes in volumes of puree during storage. These changes in volumes were converted to their respective weight equivalence. It was noticed that sample ‘A’ had the maximum decrease in weight of 7.1%, followed by that of sample ‘B’ with 5% weight decrease and then sample ‘C’ with weight decrease of 2.2%. The percentage decreased in weights of the samples can be attributed to contents collected for analysis of bacterial counts which were estimated as 4.29%, 2.92% and 2.29% for samples A, B and C respectively.

From the percentages above, it was observed that the total percentage decreased in weight of puree in sample ‘C’ (2.20%) was approximately equivalent to the percentage decrease in weight of puree (2.29%) due to collection of sample for analyses. Hence, sample ‘C’ remained unchanged in weight for the storage period. On the other hand, total decreases in weight percentages of puree in samples ‘A’ and ‘B’ (i.e. 7.10% and 5.00%) were greater compared to their respective percentages collected for analyses. These large decreases in weight of samples ‘A’ and ‘B’ can be attributed to the action of fungi on the samples.

Table 2: Volumes of tomato puree at different moisture content level stored over a period of eight months

Time, days	Volume of tomato puree, cm^3		
	Sample A	Sample B	Sample C
1	69.22	101.79	129.88
2	68.81	100.97	129.07
3	68.4	100.57	128.66
4	68.4	100.16	128.25
5	67.99	99.75	127.85
6	67.99	99.75	127.85
7	67.18	99.75	127.85
30	66.77	99.34	127.44
90	65.96	99.34	127.44
180	64.33	96.90	127.44
240	64.33	96.90	127.03

In addition, taking sample ‘C’ as our standard, t-distribution at 0.02% significant level revealed that there were significant differences in weights of tomato puree in samples ‘A’ and ‘B’ as tabulated in Table 3.

Sample 'C' underwent neither color change nor weight change and no bacterium for the eight months of storage. This observation can be attributed to the compatibility between the initial amounts of moisture content exhausted (25.0%) and the amounts of sodium meta-bisulphite used as the stabilizer.

Table 3: Summary of t-test for tomato puree at different moisture content level using sample "C" as standard at 0.02% significant level

	Sample "A"	Sample "B"	Sample "C"
Mean $\bar{x}$	67.22	99.57	128.07
Standard deviation, s	1.70	1.51	0.84
Sample size, n	11.00	11.00	11.00
$t_{calculated}$	106.22	54.76	-
t_{table}	-3.55 to 3.55	-3.55 to 3.55	-
Remark	Significant	Significant	-

5. Conclusions

From the results obtained in this investigation, sample 'C' showed no color change, no bacterium, the pH ranged between 4.2-4.45 and weight of tomato puree in the container remained unchanged during the eight months of storage. Therefore, if tomato puree is stored in airtight cans at ambient temperature and moisture content level of 90.63% using a combination of vacuum evaporation (canning) and sodium meta-bisulphite (chemical) preservation techniques, the shelf life of tomato can be extended up to eight months while retaining its essential consumer qualities. Thus, sample 'C' can be used to preserve tomato in commercial quantity since the minimum shelf life for canned foods in Nigeria is six months.

On the other hand, there were changes in the color of samples A and B form bright red to dark brown. In addition, the pH for these samples ranged between 5.0-5.4.

This study recommends that the Federal, State and Local Governments, wealthy individuals and corporate organizations should endeavor to exploit the findings and use them to establish pilot plants for the processing of tomato. This will create jobs for our teeming unemployed youths, increase in our farm input and income, reduce wastages, reduce our dependence on foreign products and lead to technological development. In addition, the equipment required for the establishment of this type of plant can be designed and fabricated locally using indigenous technology.

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