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RESEARCH PAPER

Development of Heat Processed Tomato Salsa and its Shelf-Life Extension Using HDPE and Retort Packaging

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Abstract

Fresh and processed tomato consumption has increased significantly over the past two decades. Tomato as vegetable and fruit occupy a prominent place in healthy diet. Tomato is grown extensively throughout India for fresh consumption and commercial processing. The aim of the present investigation was to develop heat processed tomato salsa (HPTS) as shelf life extension point of view. In present work, Mexican tomato salsa was reformulated and prepared by heat processing with slight modification in recipe, packed in retort pouches and HDPE packs and kept for storage at 25°C to 30°C (ambient room temperature). Prepared HPTS were evaluated for chemical and microbial analysis. It was found that, retort pouches and HDPE pouches preserve the physico-chemical parameters of HPTS up to 90 days as compared to fresh tomato salsa (control sample) (4 days at room 25°C to 30°C and refrigeration temperature (1°C to 4°C). Negligible microbial activity found up to 105 days in both the packaging material which was far better than control salsa. HPTS was further studied for sensory analysis and found to have better acceptability in HDPE packs (up to 90 days) and retort pouches (up to 60 days) as compared to control it was better. It was revealed that HPTS packed in HDPE packs and retort pouches had shown to be 22 times and 15 times extended shelf-life compare with Fresh tomato salsa.

Keywords: Heat Processed Tomato Salsa, HDPE, Retort Pouches, Microbial Count, Shelf-life

Fresh and processed tomato processing and consumption has wide significance in the United States. The analysis indicates that per capita fresh tomato consumption is greatest in the North-Eastern and Western areas of the country while processed tomatoes are most popular in the West and Midwest (Lucier *et al.* 2000). Tomato as vegetable and Fruit occupy a prominent place in healthy diet, due to presence of potent antioxidant e.g. lycopene (Munde *et al.* 2017).

Tomato salsa is a spicy sauce of chopped, cooked or uncooked vegetables or fruits, especially tomatoes, onion, chilli, celery and condiments to enhance the flavour etc. Tomato salsa serves with Nachos which is Mexican Snack. Salsa is a favourite food of many individuals and is often eaten with corn chips and other so called "Mexican food". Salsa is typically prepared by cutting up tomatoes, onion greens, and other fresh vegetables and by then mixing these vegetables together and adding seasoning. Salsa has been made for decades using the foregoing conventional procedure. While this conventional procedure often produces salsa, which has an excellent taste and consistency, it is time consuming to buy the vegetables, take out a cutting board, cut up the vegetables, mix the vegetables together, add seasoning to the vegetable mixture, and clean up the cutting board and utensils utilizing in making

the salsa. Another disadvantage of the conventional procedure is that. The fresh vegetables used to make conventional salsa also have a short shelf life (Perez, 2003).

Salsa is the Spanish word for sauce, and in Mexico it refers to sauces that are used as an ingredient for a variety of dishes and as a condiment. Most salsas are especially spicy, due to the prominence of hot chilli peppers in their ingredients. Literally hundreds of such sauces exist, including piquant fruit salsas. In the United States, salsa resembles a spicy tomato sauce from Mexico called salsa crud, or raw salsa, and is used primarily as a condiment, especially with tortilla chips. In 1991, salsa outsold ketchup as the most popular condiment in America.

There was no potential health problem associated with Mexican salsas, enchilada and taco, because of the low pH resulting from using vinegar as an ingredient, which prevented the growth of food borne pathogens. Potential spoilage of the salsa is an important consideration because most spices contribute a large number of microorganisms, including spoilage types, to a food product (Julseth *et al.* 1974).

Mexican food is popular among Indian people. People enjoy eating out in Mexican restaurant and this has leads the hotel, industry to serve Mexican cuisine as specialty. People come in restaurant eating various dish, but one of the most popular dish is Tomato Salsa with Nachos, and therefore, we decided to develop and standardize Tomato Salsa and preserve the same in a manner it could be sold in retail markets.

Motive of the study is to develop a standardized and stable tomato salsa with required taste and texture without the use of preservatives for an ambient storage with a shelf life of at least 3 months.

The problem in the daily tomato salsa making in restaurants or hotels include changes in the product due to changes in the raw materials, cooking methods, chefs, location of restaurant, etc. Furthermore, the current tomato salsa made in restaurant has shelf life of 2-3 days under refrigeration, and needs to be made frequently, in small batches. This also leads to higher costs. Therefore, the work also focuses on development of a standardized and stable tomato salsa with required taste and texture without the use of preservatives for ambient storage.

MATERIALS AND METHODS

This present study was carried out in National Agriculture Food Analysis and Research Institute, Pune. The various analysis required during study was carried out in departmental lab of National Agriculture Food Analysis and Research Institute, Pune.

Ingredients

Tomato, onion, celery, green chilli, coriander seeds powder, black pepper powder, salt, liquid glucose syrup, red vinegar, white vinegar. Vegetables were purchased from market yard, Pune and other ingredients were purchased from grocery shops.

Physicochemical analysis of raw material and Salsa

Table 1: Methods for the Physicochemical Analysis and Instruments

Physico-chemical analysis	Method and instrument used
Moisture (%)	Muley *et al.* (2014)- Hot air oven
Ash (%)	Ranganna (1995)- Muffle furnace
Fat (%)	Ranganna (1995)- soxhlet
Protein (%)	Ranganna (1995)- Protein analyzer
Crude fibre (%)	Ranganna (1995)- Crude fibre analyzer
Carbohydrates (%)	Ranganna (1995)- UV Spectrophotometer 2205
TSS	Kader *et al.* (2003)- Refractometer
pH	Bhalerao *et al.* (2017)- pH meter
Titratable acidity (%)	Bhalerao *et al.* (2017)
Reducing Sugar (%)	Ranganna (1977)
Total plate count (cfu/ml)	da Silva *et al.* (2012)
Yeast and Mould (cfu/ml)	da Silva *et al.* (2012)
Mesophilic Test (cfu/ml)	da Silva *et al.* (2012)
Thermophilic Test (cfu/ml)	da Silva *et al.* (2012)

Table 2: Tomato salsa recipe

Ingredient	Fresh%
Canned whole tomato	85.068
Jalapeño peppers, canned sliced	1.46
Onion	4.88
Cilantro	2.92
Salt	0.62
Black pepper	0.195
Garlic, fresh	1.84
Dried red pepper flakes	0.18
Lime juice	2.92
Potassium Sorbet	0.10

Ma et al. (2010).

Table 3: Standardized Tomato salsa recipe

Ingredient	Fresh%
Tomatoes, fresh commercially diced (5 mm)	78.76
Onions, frozen diced	16.13
Green Chilli	1.2
Celery	1.50
Red vinegar	0.6
White Vinegar	0.6
Coriander seeds powder	1.0
Black pepper powder	0.5
Liquid glucose syrup	1.11
Potassium Sorbet	0.10

Preparation of fresh salsa

Fresh onion, celery, green chilli were chopped together in the food processor for 5 seconds, or until a uniform particle shape was obtained for onions (~5 mm). That mixture was added to predicted fresh tomatoes and mixed thoroughly. Coriander seeds powder, black pepper powder, salt, liquid glucose syrup, red vinegar, white vinegar and 0.1% potassium sorbate were added. Citric acid, capsaicin (active component of chilli), and honey were added in varying levels specified by the test design. The salsa was placed in 2 kg glass jar and kept for storage at refrigerated and room temperature in preliminary testing to allow flavour blending.

Preparation of heat-processed salsa (HPTS)

The salsa was made in 1.5 kg batches. Canned whole tomatoes (Hunt's) were chopped in a food processor (Regal, Kewaskum, WI) for 5 seconds. Frozen chopped onion, celery, green Chilli were chopped together in the food processor for 5 seconds with a double-edged S-blade, or until a desired and uniform particle shape was obtained for onions (~5 mm). Those ingredients were added to the chopped tomatoes and mixed thoroughly. Commercially available lime juice (ReaLime); 0.1% potassium sorbate (Bakers), as suggested Pederson *et al.* (1988) and Salt, Liquid glucose syrup, Red vinegar, White Vinegar were added at various levels specified by the test design. The salsa was heat-processed to 180°C in a steam-jacketed, open-air kettle (Groen, Elk Grove, Il) and hot-filled into HDPE and retort pouches, which were sterilized by boiling for 10 min. The samples were cooled to room temperature, and stored for storage at refrigeration temperature and room temperature and analyzed for shelf-life, Allison *et al.* (1999).

Sensory Evaluation

The organoleptic characteristics of fresh tomato salsa and heat processed tomato salsa were evaluated. The panel member ware trained (Food technologist from national agriculture food analysis and research institute) and untrained (consumers). The panellists were asked to evaluate the FTS and HPTS based on approval of the flavour, colour, texture, appearance, mouth feel, after taste and overall acceptability on a 9-point hedonic scale. The value scales ranged from 9 (like, extremely) to 1 (dislike extremely) for each organoleptic attribute (Kudake *et al.* 2017; Kudake *et al.* 2018). Samples were served on white plastic dishes presented in random. For rinsing between samples, drinking water was available to the assessors Girardot *et al.* (1952).

Statistical analysis

All the results were performed in triplicates and results are expressed as mean ± SE. The mean, standard deviation and standard error were calculated by using Microsoft Excel, 2010 (Kudake *et al.* 2017; Kudake *et al.* 2018).

RESULTS AND DISCUSSION

In the present study, there was an attempt to develop HPTS with the objective to extend shelf-life and analysed for changes in physicochemical properties and consumer acceptance during storage period at room and refrigeration.

Raw material analysis

Table 4: Raw Material Analysis (Mean ± SE)

Sample	Moisture (%)	TSS (°B)	Titratable acidity (%)	pH
Tomato	90.4±0.04	4.23±0.7	0.11±0.03	4.4±0.4
Chilli	89.91±0.4	4.2±0.04	0.1±0.04	5.89±0.008
Onion	82.77±0.05	0.56±0.5	0.7±0.02	5.2±0.02
Celery	93.16±0.7	0.76±0.04	0.1±0.04	5.7±0.04

Table 4 shows that the results of raw material for % moisture, total soluble solids, acidity and pH as comparing with literature data Teka, T.A. (2013), Razali *et al.* (2015) and Fatideh, M.M. and Asil, M.H. (2012). Results of moisture contents for tomato (90.4), chilli (89.91) and celery (93.16) which were quite like literature values while in onion it was lower than standard it might be due to longer storage period. TSS, acidity and pH of all raw materials were found to be quite similar as compared with literature showed by Castillo *et al.* (2009).

Storage Study of Fresh Tomato Salsa (FTS)

Table 5: Physicochemical Analysis of FTS stored at Room Temperature (Mean ± SE)

Storage time (days)	TSS(°B)	Acidity (%)	pH
0	10.23±0.03	0.45±0.03	4.63±0.01
2	10.21±0.004	0.38±0.03	4.64±00
4	10.22±0.004	0.38±0.05	4.64±0.004

Table 5 shows that FTS was having about 10.23 °B; pH 4.63 and titratable acidity 0.41% was on 0 day. While on 2nd and 4th day there was no notable change in TSS and pH; Change in acidity from 0.45-0.38 was observed that may due to aging of salsa on storage.

Table 6: Physicochemical Analysis of FTS Stored at Refrigerated Temperature

Storage time (days)	TSS(°B)	Acidity (%)	pH
0	10.24±0.03	0.41±0.02	4.63±0.01
2	10.22±0.004	0.40±0.03	4.64±0.02
4	10.21±0.03	0.34±0.03	4.65±0.004
6	10.23±0.004	0.34±0.03	4.66±00.004
8	10.22±0.004	0.34±0.02	4.65±0.005

From table 6 it is revealed that the FTS stored at refrigeration temperature, there was no meaningful change in TSS; it also shows that slight increase in pH (4.65) and acidity gets reduced to 0.34 on 4th day of storage may due to ripening of salsa Ma *et al.* (2010).

Table 7: Microbial Analysis of FTS

Storage time (days)	Refrigerated FTS		Room Temperature FTS	
	TPC (cfu/ml)	Y&M (cfu/ml)	TPC (cfu/ml)	Y&M (cfu/ml)
0	≤ 10	Nil	≤ 10	Nil
2	≤ 10	Nil	≤ 10	Nil
4	≤ 10	Nil	≥ 10	Nil
6	≤ 10	Nil	≥10	≤ 10
8	≥10	Nil	≥10	≤ 10

FTS samples Stored at ambient temperature & refrigeration temperature were analyzed for microbial spoilage during shelf life study of product. In the microbial analysis total plate count, yeast and mould count growth was determined.

Developed FTS samples were kept at refrigeration temperature (1°C to 4°C) and ambient room temperature (25°C to 30°C) and analyzed for total plate count and yeast and mould count. In table 7, at refrigeration temperature, up to 6 day there was TPC is less than 10 cfu/ml and later it gets increased. There was no Yeast and Mould growth observed till 8th day. At ambient room temperature after the 2nd day TPC found to be more than 10 cfu/ml while Yeast and mould count found to be nil up to 4th day. Which shows the FTS at room temperature can be acceptable up to four days only and at refrigerated it can extend for 8 days.

Table 8: Sensory Evaluation of FTS stored at Refrigeration Temperature

Storage time (days)	Refrigerated Tomato Salsa				
	Color	Flavor	Taste	Texture	Overall Acceptability
0	8.13±0.1	7.76±0.1	8.53±0.04	7.73±0.15	7.5 ±0
2	7.73±0.2	7.76±0.1	8.53±0.04	7.73±0.1	7.86±0
4	7.66±0.2	7.76±0.1	7.83±0.04	7.6±0.1	7.5±0.
6	7.66±0.2	7.6±0.1	7.5±0	7.8±0.04	7.6±0.1
8	6.6±0.1	7.03±0.5	6.3±0.2	6.2±0.2	6.1±0.2

Table 9: Sensory Evaluations of FTS stored at Room Temperature

Storage time (days)	Room temperature Tomato Salsa				
	Color	Flavor	Taste	Texture	Overall Acceptability
0	7.66±0.2	7.6±0.1	7.5±0.1	7.83±0.04	7.6±0.1
2	7.66±0.2	7.6±0.1	7.5±0.2	7.83±0.04	7.6±0.1
4	7.6±0.1	7.43±0.2	6.66±0.5	6.2±0.2	6.16±0.2

In the sensory evaluation of FTS samples stored at Refrigerated and room temperature reported that the sample at refrigerated temperature organolaptic characters gives better results up to six days while on 8th day it likes moderately. Sample at room temperature is like moderately up to 4th day only by sensory panalists.

Storage Study of HPTS in Different Packaging Materials

HPTS was Analyzed for Proximate Chemical composition, Microbial Analysis and Sensory Evaluation in 2 different packaging Material (HDPE and Retort Pouch) to study the stability of the Product.

Table 10 Shows no noticeable change in the moisture content and TSS of HTPS in both the packaging materials (HDPE and Retort Pouch) while as the storage period proceeds the decrease in Acidity while pH changes from 3.97 to 4.2 in HDPE pack and 3.97 to 4.21 in retort pack during the 90 days storage period. It was also reported that % reducing sugar content increases slightly during storage. That is due to the degradation of complex sugar by ripening. Data reveals that the both the packaging materials (HDPE and Retort Pouch) retains the chemical composition of HPTS and gives the storage stability to product.

Table 11 and table 12 shows the Sensory Evaluation of HPTS in HDPE and Retort Packs, All the sensory quality parameters of samples of HPTS packed in HDPE were liked very much up to 90 days and onwards by sensory panellist, while samples in retort pouches shows acceptability up to 60 days may due to retort cups which was transparent, because tomato contain lycopene which is light sensitive in nature.

Table 10: Effect on Chemical parameters of HPTS in HDPE and Retort (Mean ± SE)

Storage time (days)	Acidity (%)		pH		Moisture (%)		Total Soluble Solid (^{0}B)		Reducing sugar (%)	
	HDPE	Retort cup	HDPE	Retort cup	HDPE	Retort cup	HDPE	Retort cup	HDPE	Retort cup
0	0.49±0.02	0.49±0.02	3.97±0.008	3.97±0.008	85.2±0.005	85.2±0.005	23.70±0	23.70±0	13.15±0.01	13.23±0.01
15	0.45±0	0.42±0.02	4.00±0.008	4.01±0.004	85.2±0.005	85.2±0.005	23.70±0	23.71±0.008	13.15±0.01	13.22±0.00
30	0.42±0.02	0.41±0.02	4.00±0.004	4.04±0.008	85.2 ±0.005	85.2 ±0.003	23.71±0.008	23.71±0.004	13.26±0.01	13.32±0.03
45	0.4±0.02	0.40±0.03	4.01±0.004	4.05±0.004	85.2±0.005	85.2±0.005	23.72±0.004	23.73±0.004	13.34±0.01	13.36±0.01
60	0.4±0.03	0.34±0.03	4.04±0.004	4.08±0.004	85.2± 0.005	85.2± 0.004	23.73±0	23.74±0.00	13.80±0.01	13.82±1.01
75	0.34±0.02	0.34±0.03	4.09±0.008	4.13±0.004	85.2±0.005	85.2±0.005	23.73±0.004	23.73±0.004	14.3±0.01	14.42±1.01
90	0.34±0.02	0.34±0.02	4.20±0.008	4.21±0.008	85.2±0.005	85.2±0.005	23.74±0	23.74±0	15.09±0.01	15.17±0.01

Data reveals that HDPE packaging shows greater stability for sensory parameters than retort pouches although it retains better sensory quality than FTS (control).

Table 11: Sensory Hedonic 1 to 9 point chart of HPTS in HDPE Pack

Storage time (days)	HDPE Packs				
	Colour	Flavour	Taste	Texture	Overall Acceptability
0	8.13±0.1	7.76±0.1	8.53±0.04	7.73±0.15	7.5 ±0
15	8.13±0.1	7.76±0.1	8.53±0.04	7.73±0.15	7.5 ±0
30	7.66±0.2	7.76±0.1	7.83±0.04	7.6±0.1	7.5±0.
45	7.66±0.2	7.6±0.1	7.5±0	7.8±0.04	7.6±0.1
60	7.73±0.2	7.76±0.1	8.53±0.04	7.73±0.1	7.86±0
75	7.73±0.2	7.76±0.1	8.53±0.04	7.73±0.1	7.86±0
90	7.66±0.2	7.6±0.1	7.5±0	7.8±0.04	7.6±0.1

Table 12: Sensory Hedonic chart of HPTS in Retort Pouches

Storage time (days)	Retort cups Tomato Salsa				
	Colour	Flavour	Taste	Texture	Overall Acceptability
0	8.13±0.1	7.76±0.1	8.53±0.04	7.73±0.15	7.5 ±0
15	8.13±0.1	7.76±0.1	8.53±0.04	7.73±0.15	7.5 ±0
30	7.73±0.2	7.76±0.1	8.53±0.04	7.73±0.1	7.86±0
45	7.66±0.2	7.6±0.1	7.5±0	7.8±0.04	7.86±0
60	7.66±0.2	7.6±0.1	7.5±0	7.8±0.04	7.86±0
75	6.6±0.1	7.1±0.4	6.3±0.2	6.2±0.2	6.1±0.2
90	6.6±0.1	7.1±0.4	6.3±0.2	6.2±0.2	6.1±0.2

Table 13: Microbial Analysis of HPTS Samples Packed in Retort pouches and HDPE packs

	Retort Cup			
Storage time (days)	TPC (cfu/ml)	Yeast & Mould (cfu/ml)	Thermophilic (cfu/ml)	Mesophilic (cfu/ml)
0	≤ 10	Nil	≤ 10	≤ 10
15	≤ 10	Nil	≤ 10	≤ 10
30	≤ 10	Nil	≤ 10	≤ 10
45	≤ 10	Nil	≤ 10	≤ 10
60	≤ 10	Nil	≤ 10	≤ 10
75	≤ 10	Nil	≤ 10	≤ 10
90	≤ 10	Nil	≤ 10	≤ 10
105	≥ 10	Nil	≥ 10	≥ 10
	HDPE			
Storage time (days)	TPC (cfu/ml)	Yeast & Mould (cfu/ml)	Thermophilic (cfu/ml)	Mesophilic (cfu/ml)
0	≤ 10	Nil	≤ 10	≤ 10
15	≤ 10	Nil	≤ 10	≤ 10
30	≤ 10	Nil	≤ 10	≤ 10
45	≤ 10	Nil	≤ 10	≤ 10
60	≤ 10	Nil	≤ 10	≤ 10
75	≤ 10	Nil	≤ 10	≤ 10
90	≤ 10	Nil	≤ 10	≤ 10
105	≥ 10	Nil	≥ 10	≥ 10

Table 13 showed that the TPC, thermophilic, mesophilic and Yeast and Mould count of HPTS at room temperature for 0, 15, 30, 45, 60, 75, 90 and 105 days. It was revealed that up to 90 days the microbial count was ≤ 10 (cfu/ml) in Retort pouches and HDPE packs and Yeast and Mould growth was nil in both samples.

CONCLUSION

Present investigation concludes that the HPTS was standardized with comparing it to FTS which was packed in two different packaging materials like HDPE and Retort pouches.. HPTS packed in HDPE and Retort cups showed significantly increase in reducing sugar and pH. Total soluble Solids and moisture were stable at room temperature in HDPE and Retort cups. Sensory parameters showed that HPTS likes very much, which was packed in HDPE, it was highly acceptable up to 3 months. Sensory parameters like very much up to 60 days and further it was like slightly because of retort pouches. All the Microbial Parameters like TPC, Yeast and mould, Thermophilic and Mesophilic result were within FSSAI limits.

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