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PHYSICOCHEMICAL ASSESSMENT AND STORAGE STABILITY OF FRESH AND PROCESSED TOMATO SALSA WITH HERBS

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***Abstract*— The present investigation entitled, "Preparation of fresh and processed tomato salsa with herbs and to study its storage stability" was conducted with the objectives to standardize the formulation of tomato salsa, to compare sensory quality of fresh and processed tomato salsa and to study the nutritive characteristics of fresh and processed tomato salsa. Raw materials used in preparation of tomato salsa were analyzed for physical-chemical properties such as moisture, TSS, acidity, ascorbic acid, reducing sugars, ash and yield. Formulation of tomato salsa was finalized on the basis of sensory evaluation and the selected levels of vinegar, sugar, and cilantro were found to be 10%, 8% and 1.5% respectively in 70% of tomato which was the major ingredient of tomato salsa. The remaining ingredients i.e onion(5.2%), garlic(0.6%), green chilli(0.6%), capsicum(1.5%),, pepper(0.15%), cumin(0.15%), oregano(0.3%) and salt(2%) were added according to the taste acceptability of the panelists. three hydrocolloids i.e. carboxy methyl cellulose (CMC), guar gum and sodium alginate were added to the tomato salsa at different concentrations(0.2, 0.4, 0.6,0.8 and 1%) to avoid the separation of serum from the product. Shelf life of fresh tomato salsa found to be 60 days (2months) under refrigerated conditions (4-18 ˚C) and 8 to 10 days under room temperature (28-35 ˚C). There was no significant effect on total soluble solids (14 ˚B) and pH (4-4.2) but moisture (1.4%), titrable acidity(26%), ascorbic acid(54.25), reducing sugars(3.8%), lycopene(25.6%) and ash content(16%) were significantly decreased during storage in fresh tomato salsa(unprocessed) under refrigerated conditions (4-10 ˚C). Processed salsa showed significant decrease in ascorbic acid and lycopene and increase in reducing sugars at both room (28-35 ˚C) and refrigeration temperature (4-10 ˚C) Microbiological studies observed no microbial growth in processed tomato salsa packed in glass jars during 3 months of storage studies whereas during second month of storage fresh salsa sauce showed microbial growth Scores of tomato salsa packed in glass jars were found acceptable during 3 months of storage studies.**

Keywords: *Salsa,lycopene,Hydrocolloids storage stability, Total Soluble Solids*

I. INTRODUCTION

Tomato(*Lycopersicum esculentum* L.),locally known as kamatis is a herbaceous plant belonging to Solanaceae or Nightshade family. Growth habit ranges from strongly determinate (bush type)to indeterminate types bearing fruits of different shapes & sizes. Tomato as vegetable and Fruit occupy an important place in healthy diet. Tomato is grown extensively throughout India for fresh consumtion & commercial Processing(Miami and Kaur 2000,Prakash 2000).Carotenoids and Ascorbic Acid are antioxidants present inTomatoes(Giovanelli et al.2001) .Tomato has an excellent nutritional profileowing to its balanced mixture of vitamins & minerals. It is the richest source of antioxidants ,lycopene (60-90 mg /kg),phenolic acids(ferulic, chlorogenic, caffeic acids)with immune stimulatory properties(Berry 2007 and Kaur et al.2004). β carotene and lycopene contribute 1 &87 % respectively of total carotenoids in ripe & red tomatoes (Singh and Rai 2006).

Lycopene is an important natural antioxidant and it provides protection against a broad range of epithelial cancers. Being a major carotenoid in human blood and protects against oxidative changes to lipids,proteins and DNA . Lycopene induces phase two enzymes,which are helpful to eliminate carcinogens and toxins from our body and is beneficial to fight against cancer and coronary heart diseases (Singh and Rai 2006). Enhanced bioavailability of Lycopene from processed food products and increased antioxidant activity after further processing advocate consumtion of processed tomato products(Kaur et al.2004).

Tomato Salsa is one such Kind of product with low calorie , high zfibre, vitamin and mineral rich product.Tomato Salsa is described as having firm chunks of whole tomato suspended in an aqueous medium of fresh juice or pulp fully blended with chopped ingredients such as onions, garlic, salt and acid(Allison et al.1999).Salsas are combination of finely chopped fruits/ vegetables flavored with a variety of herbs, spices and other ingredients. The combined ingredients are not a puree,but are distict pieces and are often uncooked(carlsen K et al 1997).production of salsa will be beneficial to the farmers as well as enertpreneurs because it requires minimum equipment and machinery with low cost.

The present study was undertaken with the following objectives:-

- To standardize and formulate fresh and processed tomato salsa
- To compare the sensor Quality of fresh and Processed tomato salsa

- Nutritive Characteristics of fresh and processed tomato salsa

Materials & Methods

Procurement of Raw Materials : Fresh tomatoes (of mixed quality and good grade) were procured in the month of November in lots from the local market. Other ingredient like onion, garlic, green chilly , capsicum, cilantro, oregano leaves, sugar, salt and spices (pepper and cumin) powders, vinegar (non-fruit) purchased from the local market

Standardization of the recipe for tomato salsa preparation: Optimum and ripened red tomatoes were selected for processing and bruised, partially ripened and undesired tomato were sorted out manually.The graded fruits were washed thoroughly under running tap water.

Standardization of blanching time of tomato: Blanching time of tomato was standardized at temperature of boiling water (100^0C) by keeping the samples for different time intervals (2,4,6,8 seconds).The optimum blanching time was found where there was no weight loss in shortest boiling period. After blanching tomato are peeled and cut into halves to remove core and seed.

Preparation of raw material: Raw material (onion, garlic, green chilies, capsicum, cilantro and oregano leaves) were thoroughly cleaned, and yield was calculated. Blanched tomato were chopped into small cubes with hand chopper. Tomato puree was prepared by concentrating tomato juice upto 9% TSS

Method of Preparation: To Standardize the recipe ,product was made by following the recipe given by Allison et al.1999 with sensory evaluation to find out the acceptable level of ingredients.The final recipe presented in following table:

Ingredient	Amount(gm)
Tomato(chopped)	157.3
Tomato Puree	75
Capsicum(Chopped)	5
Garlic (Chopped)	2
Onion(Chopped)	35
Chillies(green, Chopped)	2
Cilantro(fresh coriander leaves)	5
Sugar	14
Salt	14
Pepper	0.5
Cumin	0.5
Oregano Leaves(dried)	1
Vinegar	30 ml

All the ingredients were mixed in a frying pan, the selected hydrocolloid was dissolved in puree and mixed with remaining ingredients and was packed in glass jars and was stored at room ($28\text{-}35^0$ C)and refrigeratedtemp ($4\text{-}10^0$ C) .Processed Tomato Salsa was heated after addition of 0.2% guar gum and simmered for 30 minutes and filled into hot cans, and glass jars and were stored at room temp ($28\text{-}35^0$ C)and refrigeratedtemp ($4\text{-}10^0$ C)

Storage studies:

The product packed in glass jars was processed in boiling water for 30 minutes.The packed product were stored under ambient and refrigerated condition for three months.Physic-chemical parameters and sensory quality of product were studied during storage at interval of fifteen days.

Physico-chemical properties- Raw material and stored product were analyzed for physico-chemical properties.Methods were followed from Ranganna(1986)Sensory evaluation was done by nine point hedonic scale

Moisture-Determined according to AOAC(2005)10g sample was weighed in a preweighed petriplate .Kept in hot air oven(70^0C for 16-18 hrs)Dried sample were cooled down to room temp in desiccator.Moisture%=initial wt.-Final wt. ×100

Total soluble solids-Determined using hand refractometer ranging $0\text{-}32^0$B readings were expressed as ^{0}B at 20^0C

pH-Determinated using pH meter calibrated with a standard buffer solution of pH4.0

Acidity-Determined titrimetrically using standardized 0.1N NAOH and Phenolphthalein as an indicator.Acidity was expressed in citric acid in raw material and acetic acid in tomato salsa.Acidity%=vol. of alkali used × vol. made×equivalent wt. of acid×N of NAOH×100Wt. of sample× aliquot used×1ooo

Sugars-Determined by Lane and Eynon(1923) methodReducing sugar were determined by 10ml of standard mixed Fehling solution in boiling condition against the filterate using methylene blue as an indicator.End point-brick red ppt%Reducing sugar= Factor×vol. made × 100 vol. used ×sample taken

Ascorbic acid-Determined by titration method10g of juice and nectar was made to 100ml volume witho.4% oxalic acid solution Then the solution was filtered To the aliquot(10ml) 15 ml of oxalic acid was added and titrated against standardized dye(0.04%). End point-faint pink colour persisted for 10-15 secondAscorbic acid(mg/100g)= titer×dye factor×vol. made up ×100Aliquot taken × weight of sample

Ash content:Determined gravimetrically5g sample was ignited over hot plate and ashedin a muffle furnace at 550^0C for 6 hours.The sample was then cooled to room temperature in a desiccator and weighed.

II. RESULTS AND DISCUSSION

Results of the study are discussed as under:

Physico-chemical characteristics of raw material.

Yield (%) of different portions of tomato has been represented in Table 1. The data regarding physico-chemical characteristics i.e. moisture, TSS, ascorbic acid, acidity, reducing sugars, ash content and yield of capsicum, cilantro, green chilli, tomato, onion, garlic and oregano have been represented in Table 2.

Yield On an average 19.0% peel, 27.5 % seed and 58.9% pulp portion were found in tomato fruit (Table 1), yield of tomato puree was 37% from whole fruit.

Table 1 : Percent yield of different portions of tomato

Sample	Yield (%)
Tomato (raw)	
Tomato puree	37.0
Tomato pulp	58.9
Tomato skin	19.0
Tomato seed	27.5

A. Moisture

Moisture content of tomato and other ingredients i.e. capsicum, cilantro, green chili , onion and garlic were found to be 94.0, 92.0, 91.5, 90.4, 90.6, 63.9 percent on the fresh weight basis. Oregano leaves (dried) found to contain 7.12% moisture content (Table 2). Berry (2007) reported that the moisture content of tomato was 93.1% Moisture content of onion was said to be ranging from 88.6-92.8% (ftp://166.111.30.161), Nwinuka et al. 2005 reported that moisture content of garlic and onion was 41 and 49 percent respectively.

B. TSS

Total soluble solids (TSS) of the tomato, capsicum, cilantro, green chili, onion and garlic were found to be 5.0, 3.4, 3.6, 4.2, 7.6 and 3.4 ºB respectively. Total soluble solids of the raw tomato were 4% Periago et al. 2004. Sethi and Ananad (1986) reported the TSS of hybrid Tomato varieties ranging from 3.8 to 4.62 ºBrix.

C. Ascorbic acid

Tomato contained 6.742 mg/100g of ascorbic acid and capsicum, cilantro, green chili, onion, garlic and oregano leaves found to contain 22.6, 6.98, 37.1, 2.35, 5.58 and 0.62 mg/100g of ascorbic acid respectively. Abushita et al. 2000 reported that the concentration of ascorbic acid ranged between 14.6 -21.7mg/100g fresh weight of ripe tomato fruit where as Hounsome et al. 2008 reported that ascorbic acid of tomato as 20mg/100g. Shi et al. 2007 reported that ascorbic acid content in whole mature-red fresh tomatoes was 13.2%.

Lopez-Hernandez et al. 1996 reported vitamin C content of Capsicum *annuum L. var*. Longum grown in Galicia peppers was 24mg/100g) Peter (2004) reported the ascorbic acid content of oregano was 45mg /100g.

D. Acidity

Acidity (% citric acid) of tomato, capsicum, cilantro, green chilli, onion, garlic and oregano was noted as 0.111%, 0.089%, 0.104%, 0.119%, 0.312%, 0.048% and 0.002% respectively, Sethi and Anand (1986) reported that the titrable acidity of hybrid varieties of tomato ranging from 0.33 to 0.48%.

E. Reducing sugars

Tomato was found to have 2.5% reducing sugars and remaining ingredients like cilantro, green chili, capsicum, onion, garlic and oregano were found to contain 0.71, 0.65, 1.81, 2.31, 0.90 and 0.06 % respectively. Kaur and Bains (1992) reported that the reducing sugars of two tomato varieties were 3.9% (Pusa Sawani) and 2.9% (Punjab Padmani). Sethi and Anand (1986) reported the Total sugars of Hybrid Tomato varieties ranging from 2.16 to 2.91%.

F. Ash content

Ash content of tomato, cilantro, green chili, capsicum, onion, garlic and oregano leaves were found to be 2.09, 0.89, 0.34, 1.20, 0.28, 0.60 and 6.40 % respectively. Tepic et al. 2006 reported that ash content of tomato inbred lines ranged from 7.62% to 9.90%. the total ash content (8.33 to 9.09%) of red mature tomatoes is a little less than 10% of the dry matter (www.oecd.org).

G. Yield

Yield of tomato was 57 %and of cilantro, green chilli, capsicum , onion, garlic and oregano were noted as 80, 87, 70, 77, 54, and 100% (dried leaves) percent respectively.

Table 2: Physico-chemical characteristics and yield of raw material

SAMPLE	MOISTURE(%)	TSS (˚B)	ACIDITY (% citric acid)	ASCORBIC ACID (mg/100g)	REDUCING SUGAR (%)	ASH (%)	YIELD (%)
Capsicum	92.0	3.4	0.09	22.6	1.81	1.20	70
Cilantro	91.5	3.6	0.10	6.98	0.71	0.89	80

Green chilli	90.4	4.2	0.12	37.1	0.65	0.34	87
Garlic	63.9	3.4	0.05	5.58	0.90	0.60	54
Onion	90.6	7.6	0.31	2.35	2.31	0.28	77
Oregano (dried leaves)	7.12	-	0.002	0.62	0.06	6.40	100
Tomato	94.0	5.0	0.11	6.74	2.70	2.09	57

H. Bio active compounds

Data subjecting bioactive compounds present in raw materials have been presented in Table 3 Tomato was found to contain 9.25 mg/100g lycopene. Total chlorophyll content in cilantro, Capsicum, green chilli and oregano was 0.45, 0.05, 0.10 and 0.71 mg/100g respectively. Onion was found to have 1.15 mg/100g anthocyanins.

Table 3: Bioactive Compounds in raw matreria

SAMPLE	Lycopene (mg/100gm)	Total chlorophyll (mg/100gm)	Anthocyanins (mg/100gm)
Tomato	9.25	-	-
Capsicum	-	0.05	-
Cilantro	-	0.45	-
Green chilli	-	0.10	-
Garlic	-	-	-
Onion	-	-	1.15
Oregano leaves	-	0.71	-

Gorinstein et al. 2009 studied antiprolifertive activity of some vegetables such as raw garlic (*Allium sativum L*), white and yellow, and red onions (*Allium cepa L*), red and green peppers (*Capsicum annuum L.)* which were harvested in the same year and in the same geographical and. climatic conditions.

I. Standardization of blanching of tomato

Time of' blanching was standardized at 6 sec. at 100˚C because the time and temperature of peeling was optimum with good retention of color, texture (firm enough to cut into small cubes) and flavor. Blanching at 1OO ˚C for 8 sec showed maximum loss of tomato pulp along with the peel and it was also found poor in texture (greasy while cutting because of overcooking of pulp material) having cooked flavor.

J. Physico-chemical and sensory evaluation of tomato salsa

Standardized recipe of tomato salsa prepared was evaluated physico- chemically and organoleptically . Sensory scores and overall acceptability scores of tomato salsa were significantly higher and then salsa was selected further for analysis of storage stability.

Physico-chemical and sensory evaluation of tomato salsa

Parameter	Salsa
Moisture (%)	85%
TSS (˚B)	13.4
Acidity (% A.A)	0.4
pH	4.5

Ascorbic Acid (mg/100g)	6.8
Lycopene (mg/100g)	9.9
Reducing Sugar (%)	5.2
Sensory parameter	
Appearance	8.5
Flavor	8.5
Consistency	7.5
Overall acceptability	8.0

K. Selection and Standardization of levels of hydrocolloid.

Fresh (unprocessed) salsa showed extensive separation of serum from the product but hydrocolloid had no effect on consistency and separation of serum of Fresh (unprocessed) salsa as the reason noted that the gelation of guar gum occurs when it was heated. So sodium alginate, CMC (carboxy methyl cellulose) and guar gum were added to processed tomato salsa with different levels of concentrations (02, 0.4. 0.6, 0.8 and 1.0 %} to avoid separation of serum from product. Organoleptic evaluation of tomato salsa with various hydrocolloids differed in levels showed significant difference in their appearance, flavor and taste, texture and consistency, overall acceptability.Guar gum has improved the flavoring characteristics of the product when compared with other hydrocolloids so guar gum with minimum quantity (0.2 %) was selected for the product.

Table 4: Effect of various hydrocolloids on the sensory parameters of tomato salsa

Hydrocolloid	Level (%)	Sensory parameter			
		Appearance	Flavor	Consistency	Overall acceptability
CMC (carboxy methyl cellulose)	0.2	6.5	7.0	7.0	7.0
	0.4	7.0	7.0	7.0	7.0
	0.6	8.0	8.0	8.0	8.0
	0.8	6.5	8.0	7.5	7.5
Sodium alginate	0.2	7.5	7.5	8.0	7.5
	0.4	7.5	8.0	8.0	8.0
	0.6	8.0	8.0	8.0	8.0
	0.8	8.5	8.0	8.0	8.0
Guar gum	0.2	8.5	8.5	8.5	8.5
	0.4	8.0	8.0	8.0	8.5
	0.6	8.0	8.5	8.0	8.5
	0.8	8.0	8.0	8.0	8.0

The consistency of tomato salsa containing 0.2 % guar gum was optimum which showed higher scores of appearance (8.5), flavor (8.5). consistency (8.5) and overall acceptability (8.5) for the product. Phillips et al. 1984 reported that guar gum showed good compatibility with the soup in terms of flavor, taste and consistency as it improved the overall mouth feel of the soup and it enabled a rounding of the different flavoring components in the soup.

Storage studies of fresh tomato salsa

Physico-chemical and sensory parameters of fresh (unprocessed) tomato salsa

There was no significant difference in total soluble solids (13.4 °B), pH (4.0-4.2) and ash content (3.2-3.6%) but moisture (83.0-85.2%), titrable acidity (0.29-0.39%), ascorbic acid (2.7-5.9 mg/100g), reducing sugars (5.02-5.2%), lycopene (8.2-10.34 mg/l00g) were significantly decreased with increase in time of

storage. Heat, light, oxygen and different food matrices are factors that have an effect on lycopene isomerization and auto-oxidation (Xianquan et al. 2005). Sensory quality of fresh tomato salsa was decreased with increasing time . Appearance, flavor, consistency and overall acceptability scores decreased significantly during storage.After storage of two months the tomato salsa stored at refrigeration temperature (4-10 ˚C) got spoiled. The fresh tomato salsa is analysed only in glass jars because in other packaging material (cans, retort pouch) it showed early spoilage. At room temperature (28-35 ˚C) the fresh salsa got spoiled within a week.

Table 5: Effect of storage on physico-chemical characteristics of fresh tomato salsa Stored at refrigeration (4-10 ˚C) temperature

Parameter	Time (days)				
	0	15	30	45	60
Moisture (%)	85.2	85.0	84.0	84.0	83.9
TSS (˚B)	13.4	13.4	13.4	13.4	13.4
Acidity (%A.A)	0.39	0.37	0.35	0.30	0.29
pH	4.06	4.06	4.05	4.15	4.26
Ascorbic acid (mg/100g)	5.98	4.51	3.91	3.50	2.73
Lycopene (mg/100g)	10.35	10.11	9.88	8.12	8.25
Reducing sugars (%)	5.29	5.23	5.20	5.11	5.08
Ash content (%)	3.55	3.57	3.59	3.60	3.60

Table 6 : Effect of storage on sensory quality of fresh tomato salsa Stored at refrigeration (4-10 ˚C) temperature

Parameter	Time (days)				
	0	15	30	45	60
Appearance	8.5	8.5	8.0	7.5	7.0
Flavor	8.5	8.0	7.8	7.5	7.0
Consistency	8.5	8.5	8.0	7.5	7.0
Overall acceptability	8.5	8.5	8.0	7.5	7.5

Effect of storage on physico-chemical and organoleptic parameters of Processed tomato salsa

Effect of storage on physico-chemical and organoleptic parameters of processed tomato salsa (packed in different packaging materials such as cans, glass jar) have been presented in Tables.

L. Moisture

The effect of storage and packaging material on moisture content as investigated during two months of storage has been represented in Table 7. There was a decreasing trend in moisture content during the storage period, being relatively higher at room temperature (28-35 ℃) as compared to refrigeration (4-10 ℃). Storage time and packaging material showed non-significant decrease in moisture content of processed tomato salsa packed in cans, glass jars.

M. TSS

Increasing trend with the storage was noticed in total soluble solids in the product packed in various packaging materials ((Table 7). The rate of increase was almost similar at both temperatures ranging from 14.8 to 15 degree brix, whereas canned salsa showed more TSS (15-16 °B) as compared to glass jars. There was non-significant effect of storage and packaging material on the TSS of the product.

N. pH

The pH was increased slightly in the product packed in all the three packaging materials represented in Table 8. There was increase in pH (3.56 - 4.7) due to ascorbic acid loss but it was non significant at room as well as refrigeration temperatures. Increasing trend in pH was more in product stored at room temperature (28-35 °C) as compared to refrigeration temperature (4-10 °C). Packaging material and storage time showed non-significant effect on pH of the processed tomato salsa.

O. Acidity

Effect of storage and different packaging materials on acidity (% acetic acid) of tomato salsa stored under room and refrigeration temperatures was found to be non-significant (Table 8). Acidity of the product packed in glass jars showed more loss as compared to canned product. Wilhelmina (2005) described that vitamin C was found to be more susceptible to loss during processing resulted in decrease in acidity.

P. Reducing sugars

The data showed (Table 9) an increase in reducing sugars content which was more at room temperature in comparison to refrigeration temperature and difference was significant which could be due to inversion of non-reducing sugars which occurs on prolonged storage conditions under high temperature. Effect of packaging on reducing sugars was found to be non-significant at both temperatures.

Q. Ascorbic acid

Data regarding effect of storage and packaging material on the ascorbic acid content of tomato salsa kept at different temperatures have been presented in Table 9. Packaging material and storage time had significant effect on ascorbic acid content of product stored at both room temperature (28-35 °C) as well as refrigeration temperature (4-10 °C). Loss of ascorbic acid in product packed in glass jars (7.28—4.11mg/100g) as compared to cans (7.22-5 .47 mg/100g). Ascorbic acid loss during tomato pulp concentration was also recorded by Goula and Adamopoulos 2006 and Abushita at al. 2000. They reported that Ascorbic acid was one of the most susceptible components toward thermal degradation. Giovanelli and Paradise 2002 reported that ascorbic acid was totally degraded in both intermediate moisture pulp (23 % moisture) and dried pulp (9 % moisture) during storage. Vashista et al. 2003 reported that after two months of storage the % loss of ascorbic acid (55 %) was significantly higher in canned tomato soup. Canned product showed more loss compared to glass jars as it was reported that heat causes severe oxidative heat damage to ascorbic acid (Zanoni et at. 1998).

R. Lycopene

The data pertaining lycopene content in tomato salsa packed in three packaging materials stored at room and refrigeration temperatures have been presented in Table 10. There was significant effect of storage and packaging material on lycopene content at room as well as refrigeration temperatures. Processing increases lycopene as compared to fresh tomato but re-isomerization takes place during storage, after oxidation lycopene molecule split, this causes loss of color and off flavor (Xianquan et al. 2005). Giovanelli and Paadiso 2002 found that lycopene and antioxidant activity of the lipophilic fraction were maximally degraded in tomato products (intermediate moisture pulp and dried pulp) stored at 4 °C. Vashista et al (2003) reported that there was 4.6 % loss of lycopene content observed in canned tomato soup and found significant during storage.

S. Ash content

Observations pertaining ash content of tomato salsa have been represented in Table 10. There was non-significant decrease in ash content during storage at room as well as refrigeration temperature and it was ranged from 5 to 7 % of wet weight basis in the product packed in cans & glass jars. Effect of packaging and storage time found to be non-significant on ash content of tomato salsa.

Table 7: Effect of storage and packaging material on Moisture and TSS of tomato salsa stored under room temperature (4-10 ˚C)and refrigeration temperature (28-35 ˚C)

Storage time (months)	Total Soluble Solids (˚B)					
	Can	Glass jar		Can	Glass jar	
	Room temp.	Room temp.	Ref. temp.	Room temp.	Room temp.	Ref. Temp
0	84.5	82.8	82.8	14	14.8	14.8
1	83.3	81.6	83.1	14	14.8	14.8
2	82.5	80.5	82.6	14	15.0	15.0
3	82.4	80.4	82.6	15	15.0	15.0

Table 8: Effect of packaging and storage on pH and acidity of tomato salsa stored under room temperature (4-10 ˚C) and refrigeration temperature (28-35 ˚C)

Storage time months	Acidity (%)					
	Can	Glass jar		Can	Glass jar	
		Room temp.	Ref. temp.	Room temp.	Room temp.	Ref. temp.
0	3.6	3.6	3.6	0.41	0.44	0.44
1	3.7	3.7	3.7	0.40	0.42	0.43
2	4.0	4.0	4.0	0.39	0.30	0.28
3	4.1	4.1	4.	0.38	0.23	0.28

Table 9: Effect of packaging and storage on reducing sugars and ascorbic acid of tomato salsa stored under room temperature (4-10 ˚C) and refrigeration temperature (28-35 ˚C)

Storage time (months)	Reducing sugars %			Ascorbic Acid (mg/100gm)		
	Can	Glass Jar		Can	Glass jar	
		Room Temp	Ref. Temp		Room temp	Ref. Temp.
0	6.63	6.88	6.88	7.22	7.28	7.28
1	7.10	7.02	6.90	6.85	6.22	6.42
2	7.46	7.21	7.32	6.11	5.80	5.21
3	7.55	7.40	7.55	5.98	4.77	5.16

Table 10: Effect of packaging and storage on lycopene content and ash content of tomato salsa stored under room temperature (4-10 ˚C) and refrigeration temperature (28-35 ˚C)

Storage time (months)	Lycopene & Ash Content (%)					
	Can	Glass jar		Can	Glass jar	
	Room temp.	Roomtemp.	Ref. temp.	Room temp.	Room temp	Ref. Temp
0	12.70	12.09	12.09	6.00	5.82	5.47
1	11.72	11.89	11.80	5.85	5.02	5.43

2	9.56	9.55	11.32	5.73	4.81	5.15
3	8.90	9.89	10.49	5.70	4.88	5.00

Table 11: Effect of packaging and storage on appearance and flavor of tomato salsa stored under room temperature (4-10 ˚C) and refrigeration temperature (28-35 ˚C)

Storage time (months)	Appearance & Flavor					
	Can	Glass jar		Can	Glass jar	
	Room temp.	Room temp.	Ref temp.	Room temp.	Room temp.	Ref. Temp
0	9.0	7.5	7.5	8.0	8.0	8.0
1	8.5	7.5	7.5	8.0	8.0	7.5
2	8.5	7.0	7.0	7.5	7.5	7.5
3	8.0	7.0	7.0	7.5	7.5	7.5

Table 12: Effect of packaging and storage on consistency and overall acceptability of tomato salsa stored under room temperature (4-10 ˚C) and refrigeration temperature (28-35 ˚C)

Storage time (months)	Consistency & Overall acceptability					
	Can	Glass jar		Can	Glass jar	
	Room temp.	Room temp.	Ref. temp.	Room temp.	Roomtemp	Ref.temp.
0	7.8	8.0	8.0	7.5	7.5	7.5
1	8.0	7.5	7.5	7.5	7.5	7.5
2	8.0	7.5	7.5	7.0	7.5	7.5
3	7.5	7.5	7.5	7.0	7.5	7.5

III. SENSORY PARAMETERS

Sensory evaluation carried out by semi trained panelist (no.6) on a hedonic scale and was represented in tables.

A. Appearance

Sensory scores regarding appearance have been given in Table11. It was found that both packaging material and storage showed non-significant effect on appearance at room (28-35 ℃) as well as refrigeration temperatures (4-10 ˚C). Product in glass jars stored at refrigeration temperatures (4-10 ℃) rated maximum for appearance by semi-trained panelists as compared to cans during storage of four months.

B. Flavor

Data regarding panelist scores for flavor have been presented.in Table 11 and it was observe that effect of storage and packaging was non-significant on flavor of tomato salsa. There was decreasing trend in scores with increase in time but was lesser in the product stored in glass jars at refrigeration temperature (4-10 °C) compared to room temperature (28-35 °C). There was non-significant effect of packaging material on flavor scores of the product at both the temperatures.

C. Consistency

Effect of storage and packaging material on texture and consistency of tomato salsa was significant at room temperature where as it was non-significant at refrigeration temperature (table 12). It was concluded that temperature has greater effect on the sensory quality of product. Tomato salsa packed in glass jars stored at refrigeration temperature (4-10 °C) scored more followed by canned product during three months of storage. Effect of packaging was found non- significant on consistency of tomato salsa.

D. Overall acceptability

Overall acceptability of the product was presented in Table 12, and it was observed that packaging material and storage had non-significant effect on overall acceptability at refrigeration temperature, but had significant effect at room temperatures. Product stored in cans and glass jars at refrigeration temperature showed more acceptability

IV. CONCLUSION

The present investigation entitled, "Preparation of fresh and processed tomato salsa with herbs and to study its storage stability" was conducted with the objectives to standardize the formulation of tomato salsa, to compare sensory quality of fresh and processed tomato salsa and to study the nutritive characteristics of fresh and processed tomato salsa. Raw materials used in preparation of tomato salsa were analyzed for physical-chemical properties such as moisture, TSS, acidity, ascorbic acid, reducing sugars, ash and yield.Shelf life of fresh tomato salsa found to be 60 days (2months) under refrigerated conditions (4-18 ˚C) and 8 to 10 days under room temperature (28-35 ˚C). There was no significant effect on total soluble solids (14 ˚B) and pH (4-4.2) but moisture (1.4%), titrable acidity(26%), ascorbic acid(54.25), reducing sugars(3.8%), lycopene(25.6%) and ash content(16%) were significantly decreased during storage in fresh tomato salsa(unprocessed) under refrigerated conditions (4-10 ˚C).

Processed salsa showed significant decrease in ascorbic acid and lycopene and increase in reducing sugars at both room (28-35 ˚C) and refrigeration temperature (4-10 ˚C). There was significant increase in reducing sugars of tomato salsa packed in glass jars stored at room temp(16%) followed by cans(14%), Maximum retention of lycopene was found in tomato salsa packed in glass jars stored at refrigeration temp (91%) followed by glass jars stored at refrigeration temp(80%),During storage of processed tomato salsa the parameters like moisture, acidity and ash content were found to decrease and pH and TSS were found to increase non-significantly irrespective of packaging material used. Sensory parameters like appearance and flavor showed non- significant decrease whereas consistency and overall acceptability showed non-significant increase in tomato salsa stored under room temperature. At refrigeration temperature (4-10 ˚C) there was non-significant effect of storage on the sensory parameters of tomato salsa packed in all packaging materials.

The shelf life of fresh (unprocessed) salsa was one week at room temperature (28-35 ˚C) and 2 months at (4-10^{0}C) while that processed salsa remained highly acceptable up till 3months of storage studies at both the temperatures in all kind of packaging material used. There was no spoilage was observed in processed tomato salsa packed in cans, glass jars, during 3 months of storage studies at room as well as refrigeration temperatures.

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