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Nutritional, Physico-Chemical and Microbiological Evaluation of Sauce, Ketchup and Puree Available in Kashmir Valley, India

Tawseef Ahmad; Farhana Allai*
[1]Department of Food Technology, Islamic University of Science and Technology J&K Pulwama 192122
[2]Department of Food Technology, Islamic University of Science and Technology J&K Pulwama 192122
* faruallai@gmail.com

Abstract
The main aim of the study was to compare the nutritional, physico- chemical, sensory and microbiological quality of two different brands (Heinz and Hyacinths) of sauce, puree and ketchup available in local market of J&K. The results indicated that sauce, puree and ketchup of Heinz recorded maximum overall acceptability on 5 point hedonic scale. On the basis of physico- chemical analysis, it was observed that protein content of sauce, puree and ketchup for Heinz varied from 0.15%, 0.23%, and 0.22% respectively and 0.09%, 0.13% and 0.11% for Hyacinths. Moisture, fiber, ash and carbohydrate content of both brands varied significantly. Fat content of Heinz products ranges from 0.02%, 0.51% and 0.04% and for Hyacinths product varied from 0.66%, 0.79% and 0.75% respectively. The Nutritional properties, vitamin C content, preservatives and microbiological quality were determined for all samples.

Keywords: Tomato; sauce; puree; ketchup; nutritional; sensory

1. Introduction
Tomatoes (*Lycopersicon esculentum*) are cultivated and consumed in several parts of countries throughout the world for its edible red fruit popularity. Tomatoes are known for its rich source of carotenoids and lycopene. Lycopene is a phytochemical nutrient present in different fruits and vegetables; it is the predominant carotenoid in tomatoes (Gartner et al., 1997). In tomatoes the lycopene content is present in abundance and thus imparts natural red color to it. Tomatoes are commonly consumed either fresh or processed. During the peak harvesting period there has been glut of tomatoes in the market. 20-40% of the losses are reported at different stages of grading, packing, transport and storage (Kaur et al., 2004). Due to their perishable nature it is further processed into different products like tomato juice, cocktail, paste, sauce, ketchup, puree, soups, powders etc in order to make it available during off seasons. Supplementation of tomato products, having lycopene content has been reported to lower biomarkers of oxidative stress and carcinogenesis (Basu and Imrhan 2006).

Tomato and tomato products are important not only for large amount of consumption but for its health and nutritional contributions to humans. Tomato products like puree, sauce and ketchup are commonly used commodities in restaurants, fast food industry and households. These products are used to enhance the flavor and taste of different food products. Ketchup is a sweeter and diluted version of puree (pulp). Tomato sauce tastes sour and sweet. Both ketchup and sauce are served with food and snacks. At present the market of puree, ketchup and sauce is dominated by brands like Maggi and Kissan. There is no such basic difference between puree, sauce and ketchups. Purees have thicker consistency and intense aroma than sauce. Sauce is generally thinner and contains more total solids (30%) than ketchups (28%). Tomato sauce and ketchup are produced from fresh tomatoes by washing, crushing into pulp, concentration and seasoning with different ingredients such as sugar, salt, spices and vinegar and then bottled or canned. Ketchups and sauces are pasteurized to

increase the shelf life but basic principle of preservation is use of salt, sugar, acid and vinegar like citric acid and acetic acid which inhibits the growth of microorganisms causing spoilage or food poisoning. pH is another important criteria, any change in pH could support the growth of pathogens (FDA,2001).

Tomatoes are rich source of Vitamin A and C. They also contain Vitamin B_1, folacin, B_6, and some minerals (Ca, K, Mg and Fe) (USDA, 1984). Zn, Cu, and Mn are the essential minerals present in the tomatoes that are used for the synthesis of some antioxidant enzymes (Leoni, 2002). Tomatoes are composed of 93-95% water and the remaining consists of 5-7% inorganic acids like citric and malic acid, sugars (sucrose, fructose and glucose), solids insoluble in alcohol, carotenoids and lipids (Silva et al., 2008). Carotenoids are essential for humans because of the neutraceutical property (Silva et al., 2008). Lycopene is reported to give protection against cardiovascular diseases and cancer (Willcox et al., 2003; Sesso et al., 2004; Walfisch et al., 2007). Owing to their popularity and ubiquitous presence in Indian Markets, sauce, ketchup and puree are important items of one's diet providing nutrients. Tomato products are best vehicles to carry the nutrients to meet the nutritional demand of common consumers. There is growing awareness among the consumers regarding the constituents that affect health both positively and negatively. The number of such health conscious consumers is fast increasing and so is the health food industry. New foods like sauce, puree and ketchup with new health claims are flooding the market to meet the diverse demands of consumers. The objective of this research "Analysis of different sauce, puree and ketchup samples available in Kashmir valley" is to study and compare their physicochemical, sensory, color analysis as well as their microbial load.

2. Materials and Methods

The study was conducted to evaluate the quality of sauce, ketchups and purees for their nutritional, physico chemical, sensory, and microbiological content. Two samples of each type of sauce, puree and ketchups of reputed brands "Hyacinths" and "Heinz" were procured from the local market of J&K and carried to Food Technology Laboratory for analysis of various parameters.

2.1 Determination of proximate analysis of Puree, Sauce and Ketchup

Total soluble solids (Brix^o) were determined by hand refractometer of range 0-32^0 Brix and 28-61^0 Brix (Atago Manual Japan), the values were recorded at room temperature (Ranganna, 1986). Total sugar was calculated by phenol sulphuric acid method and reducing sugar was determined according to the Lane and Eynon method. Titrable acidity was estimated with the visual acid-base method (Ranganna, 1986). The pH was measured at room temperature using a digital pH meter (Model LabIndia). The pH meter was calibrated with buffer standards of pH 4 and pH 10.

The moisture content was determined by the digital moisture analyzer. Protein content was measured according to the method of Kirk and Sawyer 1991. Crude fiber, ash and fat content were estimated by the standard procedure of AOAC method (AOAC 2005). The total carbohydrate was determined by the method described by Osborn and Voogt, 1978.

2.2 Determination of vitamin-C

Vitamin C was determined by the titremetric method (Ranganna, 1986) using 2, 6-dichlorophenol indophenols as an indicator.

2.3 Determination of preservatives

Sulphur di oxide was measured by titration process given by Ranganna, 1986 and Sodium Benzoate was determined by the method of krik and Sawyer, 1991.

2.4 Sensory Evaluation

Organoleptic evaluation of sauce, ketchups and Puree were determined by a semi-trained panel. Each sensory attribute like appearance, flavor, taste, consistency, and texture was rated on 5 point hedonic scale, where 5 denotes excellent, 4-good, 3-average, 2-fair and 1-poor.

2.5 Microbial evaluation

Microbial evaluation was studied in terms of total plate count as described by standard procedure FDA, 2001.

2.6 Statistical analysis

Statistical analysis was carried out by using Statistical Package for Social Science (SPSS) software version 16.0. The results obtained in the present study are reported as mean values (obtained from the three replications) ± standard deviation (SD). The significant differences between mean values were analyzed by the Duncan multiple range test at a significance level of $p<0.05$.

3. Results and Discussions

The present investigation was conducted to analyze the tomato products like sauce, puree and ketchup samples available in the local market of Srinagar.

3.1 Physico –chemical Analysis

The results obtained for the physico-chemical analysis are depicted in Table 1. On evaluation of result it was found that the moisture content of puree, sauce and ketchup collected from Hyacinths was higher (46.21%, 34.22%, 35.02%) than moisture content of Heinz (27.14%, 30.22%, 29.05%) respectively. Products having high moisture content has less shelf life (Ayub et al., 2005). Ash content determines the presence of minerals present in the food. Ash content of given samples i.e sauce, puree and ketchup was reported to be 0.11%, 0.14%, and 0.22% respectively for Hyacinths and 1.43%, 1.55% and 1.76% respectively for Heinz. The variations in ash contents of the samples could be due to the formulations of each manufacturer. Higher ash content indicates high amount of fruit content in the product and vice-versa.

Fruits are usually low in protein. As fresh fruits, tomatoes and chillies contain very less amount of protein 0.85% and 0.9% respectively (USDA nutrient database, 2010). High level of protein was recorded for Heinz products (sauce-0.15%, ketchup-0.14%, puree-0.23%) and low level was recorded for Hyacinths products (sauce-0.09%, ketchups-0.11%, puree-0.13%) respectively. Different fruits usually contain fat content not greater than 1% (Sajib et al., 2014; Ara et al., 2014). In this study the fat content of Hyacinths was 0.02% for sauce, 0.04% for ketchup and 0.51% for puree and in case of Heinz 0.66% for sauce, 0.75% for ketchups and 0.79% for puree respectively. Lipid content decreases due to removal of tomato skin and there is no further addition of any ingredient containing fat. The fiber content in Heinz products was highest as compared to Hyacinths products. These two manufacturers were significantly different at 5% level of significance.

The total carbohydrate content was determined according to the difference method. Carbohydrate content between sauce, ketchup and puree of Heinz and Hyacinths were not significantly different. It was observed that the increase in moisture, protein, fat, ash and fiber content levels results in decreasing total carbohydrate levels. Therefore, the highest carbohydrate value was recorded for Hyacinths products than Heinz products.

Table 1: Physico-chemical Properties of Sauce, Ketchup and Puree

Sample	Moisture (%)			Ash (%)			Protein (%)		
	Sauce	**Ketchup**	**Puree**	**Sauce**	**Ketchup**	**Puree**	**Sauce**	**Ketchup**	**Puree**
Hyacinths	34.22± 0.21^{a}	35.02 ± 0.12^{a}	46.21± 0.01^{b}	0.11± 0.40^{b}	0.22± 0.02^{a}	0.14± 0.10^{b}	0.09± 0.03^{b}	0.11± 0.04^{b}	0.13 ± 0.21^{b}
Heinz	30.22± 0.11^{a}	29.05± 0.14^{b}	27.14± 0.01^{a}	1.55± 0.13^{a}	1.76 ± 0.21^{b}	1.55± 0.23^{b}	0.15± 0.23^{a}	0.14± 0.04^{b}	0.23± 0.09^{a}
	Fat (%)			**Fiber (%)**			**Carbohydrate (%)**		
Hyacinths	0.02±0.03^{a}	0.04±0.01^{a}	0.51±0.31^{b}	5.43± 0.02^{a}	6.92±0.32^{b}	4.08±0.23^{a}	60.13±0.34^{a}	61.09±0.22^{a}	66.17±0.13^{a}
Heinz	0.66±0.07^{b}	0.75±0.23^{b}	0.79±0.07^{a}	6.79±0.33^{b}	7.21±0.32^{b}	4.22±0.07^{b}	60.75±0.23^{a}	61.09±005^{a}	66.17±0.11^{a}

Note: Results were expressed as mean values ± standard deviation and values followed by different letters are significantly ($p<0.05$) different from each other.

3.2 Nutritional Properties

The result pertaining to the nutritional properties of sauce, ketchup and puree of two different brands of Hyacinths and Heinz are shown in Table 2. Sugar is one of the most important parameter in respect of its flavor, palatability, quality and discoloration of tomato puree, sauce and ketchup. Maximum mean score value for total sugars (TS) and reducing sugar (RS) was found to be in Heinz products while lowest was reported for Hyacinths products. The obtained data were in agreement with Sharoba *et al*., 2005. Highest quantity of total soluble solids (TSS) was found in Heinz (9.83 ^{0}Brix for puree, 32.66 ^{0}Brix for sauce, 26.43 ^{0}Brix for ketchup) while as lowest values for TSS of puree, ketchup and sauce was recorded in Hyacinths (11.20 ^{0}Brix, 26.39 ^{0}Brix, 30.40 ^{0}Brix respectively). Statistically, no significant difference was recorded in TSS of ketchup samples at P≤0.05 at level of significance. This result is in accordance with the findings of Minton, 1996.

Among these parameters, pH and titratable acidity is the most important quality parameter as it influences the acidity during thermal processing conditions required for producing different products. Puree samples were analyzed for pH. There was least difference between pH of puree collected from Hyacinths and Heinz. The mean value of pH of the puree procured from Hyacinths was 4.52 whereas the mean value of pH of puree purchased from Heinz was 4.56 (Table 2). The mean value of pH of the ketchup collected from Hyacinths was 3.80 and that of Heinz was 3.91. The samples of sauce differed significantly with each other at P≤0.05 at level of significance (Colombani et al., 2001). The finding of the study depicted that the pH of the tomato products was acidic and the variability of pH value is due to different treatment combinations between the initial pH value of raw materials and the length of cooking time after the vinegar is added. Any change in pH is directly related to the change in acidity of samples. Similar findings were recorded by Ahmad 1997 during his study on tomato products. Acidity of the fruit contributes to flavor of products. In this study, total titratable acidity varied for both the brands of Heinz (1.40% for puree, 1.55% for ketchup and 1.29% for sauce) and Hyacinths (1.35% for puree, 1.54% for ketchups and 1.37% for sauce) respectively. Decrease in titratable acidity with increased fruit maturity was due to loss of citric acid from the fruit. During ripening in tomatoes, as in other fruits, decline in acid levels is accompanied by increase in sugars. This change may be due to the metabolic conversion of acids into sugars by gluconeogenesis. The results are in agreement with those obtained by (Porretta and Birzi, 1995).

Table 2: Nutritional Properties of Sauce, Ketchup and Puree

Sample	TS (%)			RS (%)			pH		
	Sauce	**Puree**	**Ketchup**	**Sauce**	**Puree**	**Ketchup**	**Sauce**	**Puree**	**Ketchup**
Hyacinths	25.86± 0.42^b	32.01 ± 0.31^a	30.00 ± 0.06^b	12.08± 0.13^b	21.01± 0.44^a	7.92± 0.36^b	4.02± 0.03^b	4.52± 0.03^b	3.80± 0.21^b
Heinz	26.91± 0.31^b	32.11± 0.27^a	30.07± 0.22^b	12.84± 0.01^b	21.17± 0.12^a	8.01± 0.14^b	4.31± 0.05^a	4.56± 0.09^b	3.91± 0.19^a
	Acidity (%)			**TSS (^{o}Brix)**					
Hyacinths	1.37±0.03^a	1.35±0.01^b	1.54±0.17^b	32.66± 0.06^a	9.83±0.07^b	26.43±0.36^a			
Heinz	1.29±0.07^b	1.40±0.33^b	1.55±0.09^a	30.40±0.25^b	11.20±0.19^b	26.39±0.07^a			

Note: TSS= Total soluble solids, TS= Total sugars, RS= Reducing sugars. Results were expressed as mean values ± standard deviation and values followed by different letters are significantly (p<0.05) different from each other.

3.3 Vitamin C and Preservatives

Tomato products viz ketchup, puree and sauce have been proved as a good source of vitamin C. Ascorbic acid is used in the prevention of diseases related to oxidative damage occurs due to its ability to neutralize the action of the free radicals in the biological systems (Borguini and Torres, 2009). The mean value of Vit C (mg/100gm) content of puree, sauce and ketchup from hyacinths was 17.53, 5.23 and 16.36 while as for Heinz the mean value of puree, sauce and ketchup was reported as 18.78, 5.10 and 16.36 respectively (Table 3). Vitamin C is relatively unstable to heat, light and oxygen (Lin et al., 1998). Moreover the vitamin C content was highest in purees due to the fact that it was packaged in plastic pack, so contact with light reduces while as other sauces and ketchups are packaged in glass bottles.

The selected tomato samples were tested for preservatives like sodium benzoate and sulfur dioxide. Sodium benzoate content of puree, sauces and ketchups of Hyacinths were 0.02mg, 0.01mg and 0.01mg and for Heinz 0.01 mg for puree, 0.02mg for sauce and 0.01mg for ketchup. Sodium benzoate is most suitable for use as an antimicrobial agent in foods and beverages which naturally are in the pH range below 4.5%; it is not recommended as a preservative at pH ranges higher than 4.5. Sulfur dioxide content of selected puree, sauce and ketchup for Hyacinths were 0.05mg, 0.06mg and 0.13mg while as for Heinz 0.06mg for puree, 0.07mg for sauce and 0.16mg for ketchup. Sulfur preservatives, such as sulphites and Sulfur di-oxide inhibit the growth of microorganisms and prevent discoloration of sauces and ketchups.

Table 3 Vitamin C and Preservatives

Sample	Vitamin C			Sodium Benzoate			Sulphur dioxide		
	Sauce	Puree	Ketchup	Sauce	Puree	Ketchup	Sauce	Puree	Ketchup
Hyacinths	5.23± 0.22^{b}	17.53± 0.13^{a}	16.36± 0.42^{b}	0.02± 0.21^{a}	0.01± 0.07^{a}	0.01± 0.36^{b}	0.07± 0.18^{b}	0.06± 0.02^{a}	0.16± 0.11^{b}
Heinz	5.10± 0.1a^{b}	18.78± 0.07^{b}	16.36± 0.11^{b}	0.01± 0.02^{a}	0.02± 0.04^{a}	0.01± 0.45^{b}	0.06± 0.16^{b}	0.05± 0.05^{b}	0.13± 0.16^{b}

Note: Results were expressed as mean values ± standard deviation and values followed by different letters are significantly ($p<0.05$) different from each other.

3.4 Sensory Properties of Puree, Ketchup and sauce

Sensory evaluation of puree, sauce and ketchup is given in Table 4. Sensory rating of puree, sauce and ketchup for appearance showed that Heinz sample ranked at the top due to its excellent appearance followed by Hyacinths. Mean score of texture was observed to be 3.00, 3.33, 3.00 for puree, ketchup and sauce from Hyacinth brand and 4.00, 4.33 and 3.33 from Heinz brand respectively. The mean score of flavor for Heinz sauce, ketchup and puree earned maximum score of 3.33, 4.00 and 3.00 respectively followed by Hyacinths mean score value of flavor for sauce, ketchup and puree is 3.00, 3.33 and 3.00 respectively. The mean score value for taste was higher in case of Heinz products than Hyacinths. Consistency was higher in Heinz sauce, puree and ketchup with mean score value of 4.23, 3.89 and 4.00 respectively while as mean score value for Hyacinths sauce, puree and ketchup was 4.00, 3.80, and 3.95 respectively.

The mean overall acceptability of Heinz sauce, puree and ketchup was highest than Hyacinths sauce, puree and ketchup.

Table 4: Sensory Evaluation of Sauce, Puree and Ketchup

Sample	Apperance			Texture			Flavour		
	Sauce	Puree	Ketchup	Sauce	Puree	Ketchup	Sauce	Puree	Ketchup
Hyacinths	3.33± 0.22[a]	3.33± 0.24[b]	2.66± 0.04[a]	3.00± 0.31[b]	3.00± 0.27[b]	3.33± 0.33[b]	3.00± 0.03[b]	3.30± 0.07[b]	3.33± 0.27[b]
Heinz	3.66± 0.13[a]	3.66± 0.42[b]	3.33± 0.22[b]	3.33± 0.41[b]	4.00± 0.04[a]	4.30± 0.10[a]	3.33± 0.33[a]	3.00± 0.05[b]	4.00± 0.19[a]
	Consistency			Taste			Overall acceptability		
Hyacinths	4.0±0.03[a]	3.80±0.01[a]	3.90±0.31[b]	3.34± 0.02[a]	3.37±0.32[a]	3.90±0.23[b]	3.90±0.31[b]	3.82±0.14[a]	3.91±0.17[a]
Heinz	4.23±0.07[a]	3.80±0.23[a]	4.00±0.07[b]	3.55±0.33[b]	3.76±0.32[b]	4.00±0.07[b]	4.00±0.24[b]	4.02±0.42[a]	4.04±0.11[b]

Note: Results were expressed as mean values ± standard deviation and values followed by different letters are significantly ($p<0.05$) different from each other.

3.5 Microbiological Analysis

Mean total plate count of different tomato products like sauce, puree and ketchup varied from 100-300 CFU/g and is shown in Table 5. The count can be used to predict the shelf life or quality of the product. The total microbial load on nutrient agar for Heinz sauce, puree and ketchup were 100, 120, and 105. For Hyacinths the total microbial load for sauce, puree and ketchup were 110, 125, and 115 respectively. Fungal load for Heinz and Hyacinth sauce, puree and ketchup were in the range of 300CFU/g to 500CFU/g. The microbial load of given samples was compared with the acceptable limit of Total viable count, coliform, yeast and mould count for sauces and ketchups are <104 CFU/g, <10 MPN/g and <104 CFU/g (Ayele Alemu, 2009). Thus the microbiological qualities of all the products were within the acceptable limits.

Table 5: Microbiological Analysis of Sauce, Puree, and Ketchup

Sample	Total Plate Count (CFU/g)			Total Fungal (CFU/g)			Total Coliform (MNP/g)		
	Sauce	Puree	Ketchup	Sauce	Puree	Ketchup	Sauce	Puree	Ketchup
Hyacinths	110	125	115	300	210	320	<2	<2	<2
Heinz	100	120	105	300	250	300	<2	<2	<2

Note: Results were expressed as mean values ± standard deviation and values followed by different letters are significantly ($p<0.05$) different from each other.

4. Conclusion

The present study showed that the locally available puree, sauce and ketchup from two different brands vary in their nutritional, physicochemical characteristic and sensory properties. Heinz products showed best results than that of Hyacinths. These both brands contain safe levels of microbial elements for human consumption. This study also reported that tomato products are rich source of Vitamin C, TSS, TS, and RS. Preservatives quantities added in puree, sauce and ketchups are within the acceptable limit. Therefore, the study suggests that both the brands provide nutritional components for health benefits of the consumers.

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