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Antioxidant and vitamin C enrichment in sauce by admixture of tomato and bottle gourd

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Abstract
Vegetables are important food group for Indians. Vegetable food group contributes indigestible fibre, vitamin and minerals such as calcium and Iron. It is also low in fat and has low calorific value. They are beneficial in maintaining acid-alkaline balance in body and thus can help to reduce the role of medicine for better of health. Bottle gourd is very useful for relief in urinary disorders. In cooked form, it is diuretic, sedative and antibilios. Tomato is the richest source of nutrients, dietary fibers antioxidant like lycopene and beta-carotene and the compounds that protect cells from cancer. Sauce from the blend of bottlegourd and tomato was prepared using different treatments (i.e. 50-50, 60-40, 70-30 and 80-20 as T_1, T_2, T_3 and T_4 respectively). The sample was analyzed for various sensorial (colour and appearance, consistency, flavor and overall acceptability), physic-chemical (total soluble solids, pH, acidity, moisture, ash, antioxidant, protein, vitamin C, fat) and microbial counts (standard plate count (SPC), yeast and moulds and coliforms). Physico-chemical analysis (total soluble solids, pH, acidity, moisture, ash, antioxidant, protein, vitamin C, fat) revealed that the sample T_1 differed significantly ($P<0.05$). The sensory evaluation (colour and appearance, consistency, flavor and overall acceptability) showed that the scores were highest in treatment T_1. It was observed that the good quality of sauce can be prepared by using bottlegourd and tomato in the ratio of 50:50. The anti-oxidant inhibition activity was found 78.32±0.18 % and Vitamin C was 29.3±0.21 mg/ml in optimized product T1. In the microbiological analysis, it was found that the SPC (10^3cfu/ml) was lowest in T_1 while the yeast and moulds and coliforms count are found absent in all four treatments.

Keywords: Sauce, bottlegourd, tomato, vitamin C, antioxidants

1. Introduction
Sauce is a French word taken from Latin *salsa,* meaning salted (Bjorkman, 1996) [11]. Tomato Ketchup and Tomato Sauce means the product prepared by blending tomato juice/Puree/Paste of appropriate concentration with nutritive sweeteners, salt, vinegar, spices and condiments and any other ingredients suitable to the product and heating to the required consistency. Tomato Paste may be used after dilution with water suitable for the purpose of maintaining the essential composition of the product. The product may contain not less than 25.0% total soluble solids (TSS) on salt free and M/M basis and not less than 1.0% acidity (as acetic acid). Culinary Pastes / Fruits and Vegetable Sauces other than tomato sauce and soya sauce means a culinary preparation used as an adjunct to food, prepared from edible portion of any suitable fruit/vegetable including, roots, tubers and rhizomes, their pulps/purees, dried fruits, singly or in combination by blending with nutritive sweeteners, salt, spices and condiments and other ingredient appropriate to the product (FSSAI Standards, 2011) [15].
According to FSSAI Standards (2011) [15], a vegetable sauce must contain not less than 15.0% total soluble solids (TSS) on salt free and M/M basis and not less than 1.2% acidity (as acetic acid). The sauce is usually thinner in consistency than the ketchup with more total solids (minimum. 30%) than in ketchups (minimum 28%). Preparation of sauce required more or less similar ingredients as chutney and by the same method, except that in sauce, the fruit or vegetable pulp or juice used is sieved after cooking to give a smooth consistency to the final product. High quality sauces are prepared by maceration of spices, herbs, fruits and vegetables in cold vinegar or by boiling them in vinegar. Sauces should be thicken slightly by cooling and by using a funnel hot sauce are filled in bottles leaving a 2 centimeter (cm) head space at the top and the bottle are sealed or corked at once. The necks of the bottles, when cold, are dipped in paraffin wax for airtight sealing. It is advisable to pasteurize sauces after bottling because of the chances of fermentation to takes places, especially in tomato and mushroom based sauces.

Other sauces are more acidic and less likely to ferment always pasteurization should be done. The color of the sauce should be bright and usually thicken slightly on cooling (Pingale and Dighe, 2015) [37]. For the pasteurization of sauce, the bottles containing sauce are kept in boiling water for about 30 minutes (Srivastava and Kumar, 2007) [47].

Fruits and vegetables have a vital role in human nutrition. Dietary antioxidants can be added to tomato sauces by adding other vegetables like bottle gourd and other phenolic compounds from vegetables (e.g. Peppers) and spices and herbs (e.g. pepper or oregano).Bottle gourd (*Lagenaria siceraria*) is one of the most primitive domesticated plants (Pullaiah, 2006) [39] and commonly known as *lauki*, *ghiya.* It is used as food as well as medicine (Prasad, 2002; Kirtikar *et al*., 2005**)** [38, 27], and a wide variety of utensils and musical instruments. It is a rich source of water, minerals, vitamins A, C and B complex and anti-oxidants. Due to higher fiber and low fat content, bottlegourd helps in constipation and diabetes. Choline (a lipotropic factor) is found to be the highest in bottlegourd which is a great mental healer. It is used in the treatment of jaundice, diabetes, ulcer, piles, colitis, insanity, hypertension and congestive cardiac failure. The fruit pulp is used as a sedative, emetic, purgative, cooling, diuretic, antibilious and pectoral (Minocha, 2015) [32, 33]. Lowers blood pressure and enhances haemoglobin concentration in human blood. Enzymes like serum glutamic oxaloacetic transaminase (SGOT) and serum glutamic pyruvic transaminase (SGPT) which control lipid metabolism are influenced due to bottlegourd consumption. (Rahman, 2003; Mohankumar and Prasadini, 2011) [34, 40].

Tomato (*Solanum lycopersicum*) is one of the highly nutritious food ingredient utilized as an ingredient as vegetable, salads, puree, ketchups sauce and juice. It contains large amount of water, niacin, calcium and vitamins A, C and E, which is important for metabolic activities and protects body against diseases (Olaniyi *et al*., 2010; Kirstie *et al*., 2005) [35, 26]. In studies by Stahl and Sies (1992) [49] and Gartner *et al.* (1997) [19], lycopene has been found more bioavailable from heat-processed tomato products than from fresh tomatoes. Lycopene (a carotene) an essential component of tomato contributes in the prevention of cardiovascular disease and prostrate cancer (Abushita *et al*., 2000; Basuny *et al*., 2009) [3, 10]. In human diet, tomatoes and tomato products are the predominant sources of lycopene, which has been found to be available for antioxidant properties

(Stahl and Sies, 1996) [48]. Today, herbs are still found in 40% of prescriptions, and the interest for use of herbal remedies instead of chemical drugs is increasing because of lesser side effects (Craig, 1999) [14]. Ginger (*Zingiber officinale*) is a native plant of South-East Asia and has been used for medicinal purposes, as a spice and natural additives (Bartley and Jacobs, 2000) [9]. Ginger has been identified as a herbal medicinal product with pharmacological effect and used as antioxidant supplement. (Zingiber officinale) were determined. The antioxidant components analysed were polyphenols, vitamin C, β carotene, flavonoids and tannins (Shirin and Jamuna, 2010) [44]. The long term dietary intake of ginger has hypoglycaemic and hypolipidaemic effect (Ahmed and Sharma, 1997) [6]. It triggers apoptosis (Abdullah *et al*., 2010) [2] and have anti-oxidative, anti-inflammatory, anti-diabetic and anti-cancer effects (Mashhadi *et al*., 2013) [31]. Cloves are the aromatic dried bulbs of tree Eugenia caryophyllata (*Syzgium aromaticum*) and used as an important spice and also acts as an anti-septic. It posses anti-bacterial, anti-inflammatory, anti-diabetic, mosquito repellanant and many other beneficial properties and being a strong anti-oxidant (Parle and Khanna, 2011) [36]. Vinegar is a merged format of French words "vin aigre", meaning "sour wine", and can be made from almost any fermentable carbohydrate source. Acetic acid, identifies the product as vinegar consist of about 3 to 9% of vinegar content and is responsible for the tart flavor and pungent, biting odor of vinegars (Ren *et al*., 1997) [41]. Hypoglycemic property of white vinegar can be used for the treatment of type 2 diabetes (Mahmoodi *et al*., 2013) [29]. Cinnamon is a spice obtained from inner bark of several trees from genus *Cinnamomum* that is used in both sweet and savoury food. The polyphenolic polymers found in cinnamon act as antioxidants (Mancini *et al*., 1998) [30], potentiate insulin action, improve food palatability, control of glucose intolerance and diabetes (Richard *et al*., 2004) [42]. Cardamom is a spice made from the seeds of several plants in the genera *Elettaria* and *Amomum*. It is used in Unani system of medicine to treat gastrointestinal disorders such as lesions (Jamal *et al*., 2006) [24]. It exhibits gut excitatory and inhibitory effects of cholinergic and Ca^{++} antagonist, fibrinolysis and lowers blood pressure. The diuretic and sedative effects may offer added value in its use in hypertension and epilepsy (Gilani *et al*., 2008; Verma *et al*., 2009) [20, 50]. Black pepper (*Piper nigrum*) is a flowering vine in the family Piperaceae, cultivated for its fruit, which is usually dried and used as a spice and seasoning. It is used as medicine, in perfumery, preservative, stimulate digestive enzymes (Srinivasan, 2007) [46], possess anti-mutagenic and anti-tumor influences and exhibit strong antioxidant activity (Gulcin, 2005) [22]. Antimicobial activity of black pepper with special reference to its mode of action was studied and found excellent inhibition on the growth of Gram positive and Gram negative bacteria (Karsha and Lakshmi, 2010) [25]. Information on preparation of sauce with bottle gourd is lacking in the literature. Sauce prepared from tomatoes and bottle gourd in combination will not only be more nutritive probably it may show better consumer appeal. Considering these facts the present study was undertaken to develop a recipe for preparing tomato- bottle gourd mixed sauce and assess the quality attributes of product.

2. Materials and methods

2.1 Materials

Raw materials (bottlegourd, tomato, ginger, cloves, cardamom, cinnamon, blackpepper, red chilli powder, white vinegar, sugar and salt) were collected from the markets of Allahabad, Uttar Pradesh, India. Kitchen grinder, gas stove, stainless steel knife, peeler, laddle and cooking pots were used for making sauce.

2.2 Preparation of sauce

The sauce preparation process was adoted by Pingale and Dighe (2015) [37] and than process was modified. Fresh and riped tomatoes were washed separately and removed peel and seeds of bottlegourd. Separately each one chopped and boiled at 55-60^{o}C for 20-30 minutes until softens while immediately blanch the tomatoes after boiling to preserve the bright red colour of tomato from deterioration and 2 minute blanching was done and then cooled in cold water to reduce surface temperature. After that both were grinded by using grinder separately to get paste. In required ratio each were taken to make a total amount of 100g sauce. 2.3% sugar from total

quantity i.e. 7.0% is added along with spice bag (ginger-1.5%, headless clove-1.5%, cinnamon-1.5%, cardamom-0.4%, blackpepper-0.4%) for 10 min than spice bag was removed and then remaining 4.7% of sugar was added along with 1.0% salt and 0.05% red chilli powder in the paste. Further it was standardized to total soluble solids (TSS) at 15°Brix. At the end, 1.2% white vinegar was added. Prepared sauce was filled in bottles, corked, pasteurized, cooled and stored at refrigerated temperature (4°C).

2.3 Treatments combination ratios for Bottlegourd: Tomatoes used for preparation of sauce

T_1 (50:50), T_2 (60:40), T_3 (70:30) and T_4 (80:20).

T_1 = 50 % bottlegourd+50 % tomatoes (1:1)

T_2 = 60 % bottlegourd+40 % tomatoes (3:2)

T_3 = 70 % bottlegourd+30 % tomatoes (2.5:1)

T_4 = 80 % bottlegourd+20 % tomatoes (4:1)

The preparation method of above treatment has been outlined in figure 1

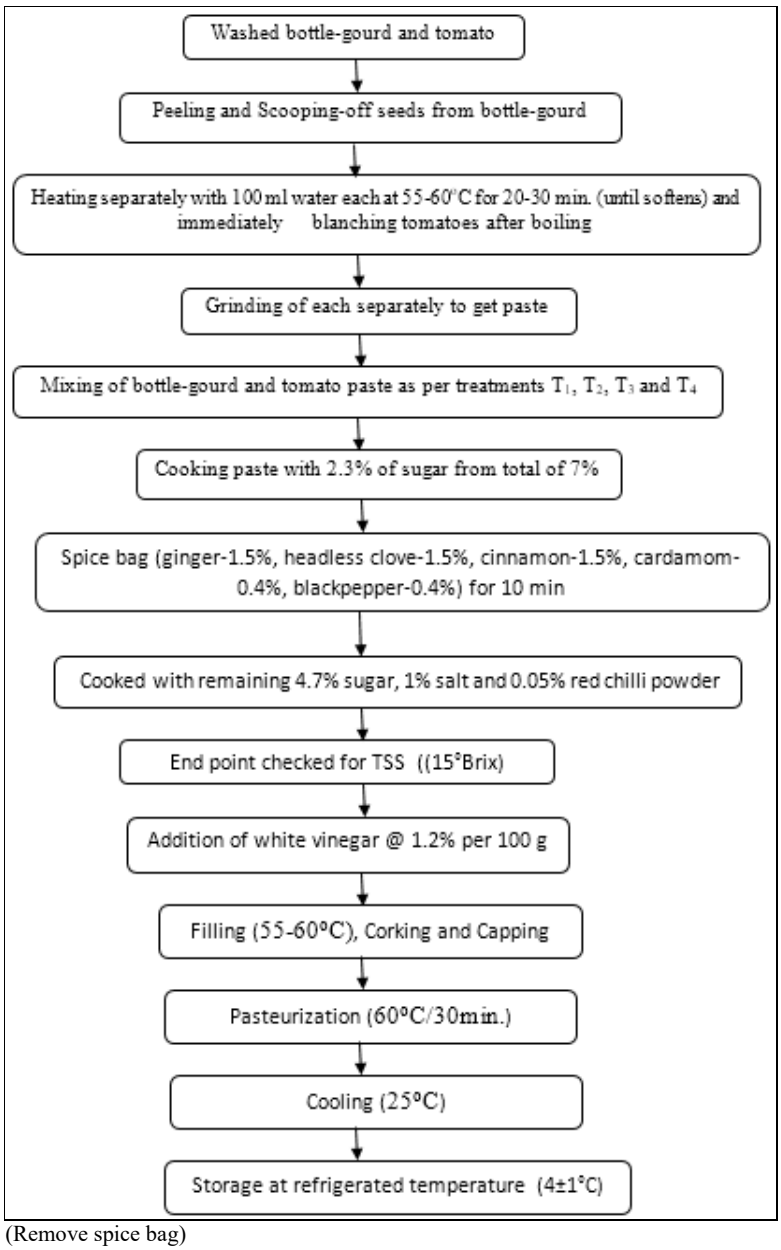

Fig 1: Preparation of sauce from blend of bottlegourd and tomato

2.5 Analysis of sauce

2.5.1 ***Sensory analysis***

A sensory evaluation of freshly prepared bottlegourd and tomato bended sauce was done by using 9 point hedonic scale on score card which includes 10 panelists of teaching faculty comprising male and female alike were used. The panelists were presented with all 4 treatments combination and asked to compare the quality of samples for flavour, colour and appearance, consistency and overall acceptability.

2.5.2 ***Physico-chemical analysis***

Total soluble solids (TSS), pH, acidity (% acetic acid), moisture, ash, protein and fat were determined by FSSAI Manual, 2012 while anti-oxidant (DPPH method) and vitamin C (A.O.A.C. Manual, 2000) [1].

2.5.3 *Microbiological analysis*
Coliform, Standard plate count (SPC), Yeast and Mold Counts were determined by FSSAI Manual, 2012.

2.6 Statistical Analysis
The data obtained were subjected to critical difference and analysis of variance (ANOVA) at 5% level of significance having number of treatments as four, number of replications as five and total number of samples as twenty.

3. Results and Discussion
3.1 Selection of level of bottle gourd addition
As mentioned earlier different levels of bottle gourd were tried to optimize the level of bottle gourd to be added to make blended sauce of tomato and bottle gourd. The basic ingredients of sauce constitute of tomato, bottle gourd, sugar and spices to prepare vegetable sauce. Trials were taken with four different levels of bottle gourd to prepare blended sauce, considering lowest and maximum highest ranges of bottle gourd and above and below the product structural integrity is not possible as per nomenclature. The different levels were 50, 60, 70 and 80% of bottle gourd was used for product formulation and designated as T1, T2, T3 and T4 respectively.

3.2 Effects of different treatments on the sensory attributes of sauce
The sensory scores for various treatments have been presented in comparative form in Table 1.

Table 1: Sensory, physico-chemical, micrbial and nutritional attributes of bottleguard and tomato sauce

Parameters	Treatment T_1 (50:50)	Treatment T_2 (60:40)	Treatment T_3 (70:30)	Treatment T_4 (80:20)	C.D. @ p=0.05
Sensory attributes					
Color and appearance	8.24±0.12	7.86±0.07	7.56±0.07	7.52±0.11	0.28
Consistency	8.16±0.03	7.4±0.11	7.2±0.10	7.08±0.12	0.30
Flavor	7.9±0.14	7.8±0.23	7.5±0.16	7.4±0.08	0.34
Overall Acceptability	7.88±0.10	7.82±0.19	7.08±0.10	6.76±0.12	0.39
Chemical composition					
Moisture %	34.16±0.29	35.16±0.29	35.68±0.24	36.02±0.26	0.58
Fat%	1.79±0.09	1.55±0.08	1.34±0.075	0.81±0.038	0.09
Protein%	1.8±0.0	1.7±0.00	1.7±0.0	1.62±0.02	0.16
Ash%	3.014±0.03	2.934±0.016	2.912±0.022	2.738±0.03	0.02
Physical parameters					
TSS (^{o} Brix)	14.62±0.215	11.7±0.071	10.94±0.116	10.38±0.124	0.392
pH	4.23±0.16	5.9±0.07	5.92±0.08	5.94±0.321	0.453
Acidity (% acetic acid)	2.13±0.58	1.72±0.376	1.36±0.58	0.27±0.02	0.076
Microbial analysis					
SPC (cfu/ml)	13.4±0.509	14.8±0.374	17.4±0.509	17.8±0.374	1.290
Yeast and Mould (cfu/ml)	Nil	Nil	Nil	Nil	Nil
Coliform (cfu/ml)	Nil	Nil	Nil	Nil	Nil
Nutritional attributes					
Anti-oxidant (% inhibition activity)	78.32±0.18	78.28±0.102	78.00±0.056	77.12±0.237	0.332
Vitamin C (mg/ml)	29.3±0.209	27.1±0.213	24.6±0.093	22.1±0.132	0.370
Cost (Rs.)	96.78	93.78	90.78	87.68	

n=5, Mean ± SE, C.D. at 5% level of significance

3.2.1 Effect on color and appearance
Below Table 1 for sauce sample with highest color and appearance score was recorded in the treatment T_1 (8.24) followed by T_2 (7.86), T_3 (7.56) and T_4 (7.52). As evident from the result of the ANOVA Table 2, for replication the F_{cal} (1.37) value was smaller than the table value of Ftab (3.26) at 5% level of significance. Therefore, the difference was not significant, indicating that there was no significant effect of replications on the color and appearance score. For treatments the F_{cal} (13.40) value was greater than the table value of Ftab (3.49) at 5% level of significance. Therefore, the difference was significant, indicating that there was significant effect of treatments on color and appearance score. This further describes that there was proper blending of ingredients. Anurag and Chawla (2016) [7] prepared burfi using bottle gourd and found that the Color score of bottle gourd *burfi* were highest recorded in sample prepared with 200% bottlegourds (200% bottle gourd shreds on khoa basis + 150g khoa=80:20 ratio of bottlegourd and tomatos) though the variation was not remarkable among various treatments. This may be attributed to more intense green color provided by bottle gourds inspite of artificial color addition to the product. Similar results were obtained from tomato puree from De Rica and Roma varieties and mean colour score were 7.6±0.52 and 7.5±0.53 respectively. While mean appearance score of tomato puree from De Rica and Roma variety was 7.2±0.79 and 7.4±0.52 respectively (Adedeji *et al*., 2015) [5]. Pingale and Dighe (2015) [37] prepared sauce by using blend of tomato:bael (70:30) ratio and colour and appearance score was recorded 9.0.

3.2.2 Effect on consistency
From Table 1, consistency score for sauce sample with highest consistency was recorded in the treatment T_1 (8.16) followed by T_2 (7.4), T_3 (7.2) and T_4 (7.08). As evident from the result of the ANOVA Table 2 indicates for replications the F_{cal} (0.74) value was smaller than the table value

Table 2: Statistical significance of sauce prepared from bottlegourd and tomato in different ratios

Parameters	ANOVA	Df	MSS	F_{tab}	F_{cal}	Result
Colour and appearance	Replication	4	0.06	3.26	1.37	NS
	Treatment	3	0.56	3.49	13.4	S
Consistency	Replication	4	0.036	3.26	0.74	NS
	Treatment	3	1.18	3.49	24.46	S
Flavor	Replication	4	0.34	3.26	3.32	NS
	Treatment	3	0.24	3.49	3.98	S
Overall acceptability	Replication	4	0.11	3.26	1.27	NS
	Treatment	3	1.56	3.49	18.49	S
Total soluble solids (°Brix)	Replication	4	0.12	3.26	1.34	NS
	Treatment	3	17.78	3.49	204.40	S
pH	Replication	4	0.16	3.26	1.49	NS
	Treatment	3	3.56	3.49	32.46	S
Acidity (% acetic acid)	Replication	4	0.04	3.26	3.23	NS
	Treatment	3	3.12	3.49	21.69	S
Moisture%	Replication	4	1.11	3.26	3.25	NS
	Treatment	3	3.28	3.49	25.26	S
Ash %	Replication	4	0.0007	3.26	0.21	NS
	Treatment	3	0.007	3.49	18.79	S
Anti-oxidant %	Replication	4	0.67	3.26	3.03	NS
	Treatment	3	1.43	3.49	6.45	S
Protein %	Replication	4	0.003	3.26	0.28	NS
	Treatment	3	1.29	3.49	120.88	S
Vitamin C %	Replication	4	0.39	3.26	3.25	NS
	Treatment	3	46.40	3.49	879.17	S
Fat %	Treatment	4	0.26	3.26	3.32	NS
	Replication	3	0.87	3.49	66.92	S
SPC (cfu/ml)	Treatment	4	1.33	3.26	1.49	NS
	Replication	3	37.52	3.49	42.07	S

Df= degree of freedom, MSS= mean sum of square, S=Satisfactory; NS=Non-satisfactory

of F_{tab} (3.26) at 5% level of significance. Therefore, the difference was not significant, indicating that there was no significant effect of replications on the consistency score. For treatments, the F_{cal} (24.46) value was greater than the table value of Ftab (3.49) at 5% level of significance. Therefore, the difference was significant, indicating that there was significant effect of treatments on the consistency score. By increasing the level of bottle gourd consistency of sauce decreases.

3.2.3 Effect on flavour

Flavour score (Table 1) for sauce sample was recorded highest in the treatment T_1 (7.9) followed by T_2 (7.8), T_3 (7.5) and T_4 (7.4). As evident from the result of the ANOVA Table 2, for replications the F_{cal} (5.524) value was greater than the table value of F_{tab} (3.26) at 5% level of significance and there was significant difference among treatments. For treatments, the F_{cal} (24.46) value was greater than the table value of F_{tab} (3.49) at 5% level of significance. Therefore, the difference was significant, indicating that there was significant effect of treatments on the flavor score. This may describes, as the level of of bottle gourd increases and tomatoes decreases, flavor score decreases as the product lost sauce like taste. Pingale and Dighe, 2015 [37] prepared sauce by using blend of tomato: bael (70: 30) ratio and the flavor score was recorded 9.0 on nine point hedonic scale. Anurag and Chawla (2016) [7] also found maxium flavour score 8.42±0.28 in treatment containing (100% bottle gourd shreds (BGS) on khoa basis + 150g khoa), which means the product contain equal amount of bottlegourd and khoa and reported that besides this increasing or decreasing the amount of bottle gourd, flavor score decrease. They reported that increasing the proportion of BGS increased the sensory scores for flavor except for the last two treatments where reverse trend between 100 and 200% BGS was observed. This may be due to higher concentration of BGS which might have masked the flavor of dairy product used in the preparation *viz* khoa. However in *burfi* with 10% BGS lowest scores were recorded (7.67). The similar trend of decreasing flavor scores with increasing pineapple pulp and ash gourd pulp in *burfi* and *peda* were observed by Bankar *et al.,* 2013 [8] and Sirsat *et al.* (2013) [45], respectively.

3.2.4 Effect on overall acceptability (OA)

OA (Table 1) for sauce sample with highest OA score was recorded in the treatment T_1 (7.88) where 50% bottle gourd and 50% tomato pulp was used. followed by T_2 (7.84), T_3 (7.08) and T_4 (6.76). As evident from the result of the ANOVA Table 2, for replications the F_{cal} (1.27) value was smaller than the table value of F_{tab} (3.26) at 5% level of significance. Therefore, the difference was not significant, indicating that there was no significant effect of replications on the OA score. For treatments the F_{cal} (24.46) value was greater than the table value of F_{tab} (3.49) at 5% level of significance. Therefore, the difference was significant, indicating that there was significant effect of treatments on the overall acceptability score. Similar results were obtained for OA of tomato puree from De Rica and Roma varieties were 7.6±0.70 and 7.9±0.57 respectively (Adedeji *et al*., 2015) [5]. The ketchup prepared with 50 % tomato pulp and 50 % mushroom pulp obtained highest organoleptic scores and was preferred than other treatments (Kumar and Ray, 2016) [28]. Pingale and Dighe (2015) [37] prepared sauce by using blend of tomato: bael (70:30) ratio and overall acceptability score was recorded 9.0. Changade *et al.* (2012) [12] also prepared bottle gourd *Kheer* by boiling 25% bottle gourd cubes in milk with 16 % sugar scored highest highest for colour, sweetness and mouth feel and overall acceptance of bottle gourd kheer and the *Kheer* prepared by boiling the 27%

bottle gourd shreds in milk with 17 % sugar scored (7.64) which is more than control (6.79) as per 9-point hedonic scale. In control sample, inplace of bottle gourd 5% rice and 7% sugar were used.

3.3 Effects of different treatments on the physico-chemical properties of sauce

3.3.1 Effect on total Soluble Soids (TSS)

From Table 1, sauce sample with highest total soluble solids (%) were recorded in the treatment T_1 (14.86) followed by T_2 (14.74), T_3 (14.78) and T_4 (14.64). As evident from the result of the ANOVA Table 2, for replications the F_{cal} (1.336) value was smaller than the F_{tab} (3.26) value at 5% level of significance. Therefore, the difference was not significant, indicating that no significant effect of replications was on the TSS percentage. For treatments the F_{cal} (204.402) value was greater than the Table value of F_{tab} (3.49) at 5% level of significance. The TSS for tomato puree was 13.13±0.28 for De Rica variety while 15.59±0.79 for Roma variety of tomatoes (Adedeji *et al.*, 2015) [5]. It was reported by Adedeji *et al.* (2012) [4], there was a decrease in values of TSS during storage probably due to the breakdown of pectin and the inhibition of low methoxyl pectin which might have occurred as reported for concentrated low acid vegetable foods.

3.3.2 Effect on pH

The sauce sample with highest pH range (Table 1) was recorded in the treatment T_4 (5.94) followed by T_3 (5.92), T_2 (5.90) and T_1 (4.23). This pH of the sample were within the range of 5.1-5.8 (approx. 5.32) of Food Safety Standard (2015). As evident from the result of the ANOVA Table 2, the F_{cal} (1.49) value was smaller than the table value of F_{tab} (3.26) at 5% level of significance. Therefore, the difference was not significant, indicating that no significant effect of replications was on the pH range. The F_{cal} (32.46) value was greater than the table value of F_{tab} (3.49) at 5% level of significance. Therefore, the difference was significant, indicating that significant effect of treatments was on the pH range. The pH for tomato puree from De Rica variety was 4.24±0.28 and 5.30±0.28 from Roma variety (Adedeji *et al.*, 2015) [5]. According to Gould (1983) [21], certain strains of *Bacillus* usually produce substances that increase the alkalinity of tomato puree. pH of sauce prepared from tomato: bael (70:30) was found 5.30 (Pingale and Dighe, 2015) [37].

3.3.4 Effect on acidity (% acetic acid)

From Table 1, sauce sample with highest acidity (% acetic acid) were recorded in the treatment T_1 (2.13) followed by T_2 (1.72), T_3 (1.36) and T_4 (0.27). As evident from the result of the ANOVA Table 2, the F_{cal} (4.31) value was greater than the table value of F_{tab} (3.26) at 5% level of significance. Therefore, the difference was significant, indicating that significant effect of replications was on the acidity percentage. The F_{cal} (21.688) value was greater than the table value of F_{tab} (3.49) at 5% level of significance. Therefore, the difference was significant, indicating that significant effect of treatments was on the acidity percentage. As the level of bottle gourd increases, the titratable acidity decreases, it afftects the taste of sauce, very low titratable acidity 0.27% (% acetic acid) observed in treatment T_4. Anurag and Chawla (2016) [7] reported that the titratable acidity and ash content showed decreasing trend with increasing proportion of bottle gourd shreds (BGS). Burfi with 10% BGS showed highest values of 2.69 and 0.95 for ash content and titratable acidity respectively, which decreased with increasing proportion of bottle gourd used. The decreasing trend may be due to buffering action of minerals present in vegetables. The similar findings of decreased acidity are concurrent with the findings of Gupta *et al.,* 2010 [23]. Titratable acidity mean score of sauce prepared from tomato: bael (70:30) was 0.96 (Pingale and Dighe, 2015) [37]. These findings were similar to tomato ketup prepared by adding different levels of mushroom pulp. Acidity (%) decreased with increasing the level of mushroom pulp with a corresponding increase in pH values (Kumar and Ray, 2016) [28].

3.3.5 Effect on moisture

The sauce sample with highest moisture (Table 1) was recorded in the treatment T_4 (36.02) followed by T_3 (35.68), T_2 (35.16) and T_1 (34.16).As evident from the result of the ANOVA Table 2, the F_{cal} (8.546) value was greater than the table value of F_{tab} (3.26) at 5% level of significance. Therefore, the difference was significant, indicating that significant effect of replications was on the moisture percentage. The F_{cal} (25.225) value was greater than the table value of F_{tab} (3.49) at 5% level of significance. Therefore, the difference was significant, indicating that significant effect of treatments was on the moisture percentage. Moisture content of fried tomato sauce was 83.5±0.8 (Salguero *et al.*, 1993) [43]. Increasing the level of bottle gourd decreased the moisture content and similar findings were recorded by Anurag and chawla (2016) [7]. Chaudhary and Verma (2011) [13] found moisture content in market sample of tomato sauce was 63.60%.

3.3.6 Effect on fat

The sauce sample with highest fat (%) was recorded in the treatment T_1(1.79) followed by T_2(1.55), T_3(1.34) and T_4(0.81).As evident from the result of the ANOVA Table 1,the F_{cal}(20.00) value was greater than the table value of F_{tab}(3.26) at 5% level of significance. Therefore, the difference was significant, indicating that significant effect of replications was on the fat percentage. The F_{cal} (66.92) value was greater than the table value of F_{tab} (3.49) at 5% level of significance. As the level of bottle gourd increases the fat content decreases. Also it can be noted down that bottle gourd is not a good source of fat content and contains 0.02 % fat in it. The result are in agreement with Anurag and Chawla (2016) [7] also reported in boutle gourd burfi that as the level of bottle gourd shreds increases, fat content decrease in product and also similar results were recorded in ash gourd peda by Sirsat *et al.* (2013) [45]. Therefore, the difference was significant, indicating that significant effect of treatments was on the fat percentage.

3.3.7 Effect on protein

The sauce sample with highest protein (Table 1) was recorded in the treatment T_1 (1.8) followed by T_2 (1.7), T_3 (1.7) and T_4 (1.6). As evident from the result of the ANOVA Table 2, the F_{cal} (0.27955) value was smaller than the table value of F_{tab} (3.26) at 5% level of significance. Therefore, the difference was not significant, indicating that no significant effect of replications was on the protein percentage. The F_{cal} (120.8835) value was greater than the table value of F_{tab} (3.49) at 5% level of significance. Therefore, the difference was significant, indicating that significant effect of treatments was on the protein percentage. Increasing the level of bottle gourd decrease the protein content in product and the similar trend

was observed by Anurag and Chalwa (2016) [7] in bottle gourd burfi and Bankar *et al.* (2013) [8] in pineapple pulp and ash gourd pulp in burfi. The protein content in market sample of tomato sauce was 0.82% (Chaudhary and Verma, 2011) [13].

3.3.8 Effect on ash

From Table 1, sauce sample with highest ash was recorded in the treatment T_1 (3.014) followed by T_2 (2.934), T_3 (2.912) and T_4 (2.738). As evident from the result of the ANOVA Table 2, the F_{cal} (0.207) value was smaller than the table value of F_{tab} (3.26) at 5% level of significance. Therefore, the difference was not significant, indicating that no significant effect of replications was on the ash percentage. The F_{cal} (18.799) value was greater than the table value of F_{tab} (3.49) at 5% level of significance. Therefore, the difference was significant, indicating that there was significant effect of treatments on the ash percentage. The ash in tomato sauce was 4.16% collected from supermarket and than analyzed (Chaudhary and Verma, 2011) [13].

3.3.9 Effect on antioxidant (% scavenging activity)

Antioxidants can eliminate free radicals and other reactive oxygen and nitrogen species, and these reactive species contribute to most chronic diseases. From Table 1, sauce sample with highest anti-oxidant (% inhibition activity) was recorded in the treatment T_1 (78.32) followed by T_2 (78.28), T_3 (78.00) and T_4 (77.12). As evident from the result of the ANOVA Table 2, the F_{cal} (3.03) value was smaller than the table value of F_{tab} (3.26) at 5% level of significance. Therefore, the difference was not significant, indicating that no significant effect of replications was on the anti-oxidant (% inhibition activity). The F_{cal} (6.45) value was greater than the table value of F_{tab} (3.49) at 5% level of significance. Therefore, the difference was significant, indicating that significant effect of treatments was on the anti-oxidant (% inhibition activity).

3.3.10 Effect on Vitamin C

From Table 1, sauce sample with highest vitamin C (%) was recorded in the treatment T_1 (29.3) followed by T_2 (27.1), T_3 (24.6) and T_4 (22.1). As evident from the result of the ANOVA Table 2, the F_{cal} (7.353) value was smaller than the table value of F_{tab} (3.26) at 5% level of significance. Therefore, the difference was not significant, indicating that no significant effect of replications was on the vitamin C percentage. The F_{cal} (879.1703) value was greater than the table value of F_{tab} (3.49) at 5% level of significance. Therefore, the difference was significant, indicating that significant effect of treatments was on the vitamin C percentage. The vitamin C content of the tomato products decreased due to thermal processing (Gahler *et al.*, 2003) [18]. Kumar and Ray (2016) [28] also reported in ketup prepared by mixing tomato pulp and mushroom plup that there was significant decrease in total soluble solids (TSS), acidity and Vitamin C with increasing level of mushroom pulp from 25,50,75 and 100% in different treatments.

3.4 Effects of different treatments on the microbial population of sauce

3.4.1 Standard Plate Count (cfu/ ml)

From Table 1, sauce sample with highest standard plate count (SPC) count (in 10^3cfu/ml) were recorded in the treatment T_4 (17.8) followed by T_3 (17.4), T_2 (14.8) and T_1 (13.4). As the level of bottle gourd increases the SPC count increases. As evident from the result of the ANOVA Table 2, the F_{cal} (1.49) value was smaller than the table value of F_{tab} (3.26) at 5% level of significance. Therefore, the difference was not significant, indicating that no significant effect of replications was on the SPC count (in 10^3cfu/ml). The F_{cal} (42.07) value was greater than the table value of F_{tab} (3.49) at 5% level of significance. Therefore, the difference was significant, indicating that significant effect of treatments was on the SPC count (in 10^3cfu/ml). As the proportion of BGS increased, the SPC count increased. The results are in agreement with study on ash gourd peda by Sirsat *et al.* (2013) [45]. This increase in count may be attributed to increase in moisture of the product with increase in level of BGS.

3.4.2 Yeast and Mould count and Coliform count (cfu/ml)

From Table 1, Yeast and Mold and Coliform count (per ml) were absent in all the sauce prepared by different treatments. In the tomato puree prepared from De Rica and Roma varieties of tomatoes, yeast and mould count were absent (Adedeji *et al.*, 2015) [5].

Black pepper has good antimicrobial activity on Gram positive bacteria like *staphyloccus aureus* followed by *Bacillus cereus* and *Staphyloccus faecalis* which are more susceptible to extracts as compared to that on Gram negative bacteria which are less susceptible. The alkaloids like piperine, piperidine, volatile oil and resins might be responsible for the antimicrobial activity of black pepper (Karsha and Lakshmi, 2010) [25].

4. Conclusion

The study has shown that tomatoes can be substituted with bottle gourd in sauce manufacture. The study indi-cated that the product prepared with 50% of tomato pulp and 50% bottle gourd pulp was preferred organoleptically than other treatments. The study also showed that the concentration of bottle gourd pulp in the sauce formulation had a significant influence in enhancing the nutritive value of product. Significant decrease in fat, protein, ash, TSS (°Brix), acidity and Vitamin C was observed with increase in level of bottle gourd pulp.

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