Indian Journal of Agricultural Sciences **84** (8): 1014–7, August 2014/Short communication

Effect of different thickeners on quality assurance and consumer preferences in tomato ketchup

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Received: 12 June 2012; Revised accepted: 30 April 2014

Key words: Carboxy Methyl Cellulose thickener, Corn flour, Quality assurance, Tomato ketchup, Vegetable thickener

More than 80% of tomatoes produced in world are consumed in the form of processed tomato juice, paste, puree, ketchup and salsa sauce. Thermal and mechanical treatments are often involved in processing of tomato which affects the tomato product quality to a greater extent (Singh *et al*. 2008). The natural loss of pectin during processing greatly results in reduced consistency as a result more serum is separated during storage which affects the consistency and acceptability in tomato ketchup (Thakur *et al*.1996). Among the tomato processed products, tomato ketchup is very popular in fast food restaurants in India and abroad. The consumption of sauce or ketchup is increased significantly as it serves as an important condiment with fast food as well as with egg, fish, poultry, meat, cheese and rice dishes (Ghoshal *et al*. 2009).

The manufacturers use various thickeners in the form of polysaccharides such as starch, gum, xanthum gum, gum arabic, guar gum and carboxy methyl cellulose to improve the consistency and overall acceptability of tomato ketchup (Ghoshal *et al*. 2009). Since the acceptability of tomato ketchup is dependent on flavour, consistency and desired sourness, the present investigation has been undertaken towards the selection of chemical thickener, carboxy methyl cellulose (CMC) and natural plant based thickener such as cooked bottle gourd, cooked pumpkin and commercial available thickener corn flour along with desired level of acidity as acetic acid for manufacture of acceptable tomato ketchup.

The experiment was planned with two levels each of four variables such as corn flour (1.5-4.0%), cooked bottle gourd (5-15%), cooked pumpkin (4-10%), CMC (0.4-1.0%) and acidity level (1.25-1.75%) as acetic acid, were standardized for the development of acceptable tomato ketchup. Fully ripened red colour hybrid tomatoes (100 kg) Sartaj from vegetable research farm of IIVR, Varanasi, were washed, cut into small pieces and were subjected to the cooking of 10 minutes in 150 litre capacity of steam jacketed kettle. The cooked tomatoes were passed through tomato pulper to remove the seed and peel of tomato from tomato pulp. Similarly bottle gourd and pumpkin (5 kg each) fruits after peeling and slicing were separately cooked to 1-4 minutes with steam under pressure and cooked pulp were blended in blender for 30-45 sec. Tomato ketchup was prepared with 13 experimental runs each from corn flour, cooked bottle gourd, cooked pumpkin and CMC stabilizer and acetic acid levels using D6 Hoax Response Surface Methodology (RSM) as per the method of Thompson (1982). The tomato pulp (80 kg) after addition of 1/3 quantity of sugar, varying levels of corn flour, bottle gourd, pumpkin and CMC stabilizer was manufactured according to the standard process of the manufacture of tomato ketchup (Singh *et al*. 2003). The tomato ketchup was hot filled (90-95^{o}C) in pre-sterilized glass bottles and corked with pre-sterilized crown cork. The tomato ketchup was stored at room temperature (29–32^{o}C) and was subjected to sensory and physico-chemical analysis. Sensory evaluation was carried out by a panel of 10 trained judges on flavour, consistency, colour and appearance and overall acceptability score on 9 point Hedonic scale (Lawless and Haymann 1998). The total soluble solids, pH, acidity, ascorbic acid and lycopene were estimated as per the method of Ranganna (1997). The serum separation in tomato ketchup was measured by centrifuging tomato ketchup (10g) samples in 25 ml graduated centrifuge at 3000 rpm for 10 min in refrigerated centrifuge. The supernatant (ml) was reflected as serum separation.

The maximum acceptance of cooked bottle gourd and pumpkin was obtained after cooking in steam under pressure for 2 min with maximum consistency and overall acceptability score (8.5). Maximum flavour score (8.3) in tomato ketchup was obtained with 0.4% CMC and 1.75% acidity and 10% cooked bottle gourd and 1.5% acidity in comparison to other thickeners for the manufacture of tomato ketchup (Fig 1d and 1b).

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Tomato ketchup manufactured with cooked bottle gourd having 10% cooked bottle gourd pulp and 1.5% acidity as acetic acid had maximum sensory score for flavour (8-8.3), consistency (7.8-7.9), sourness (7.3-7.5), colour and appearance (7.4-7.5) and overall acceptability score of 7.63-7.75 (Fig 1b). Cooked pumpkin pulp (7%) as vegetable thickener and 1.5% acidity as acetic acid in tomato ketchup was also acceptable to judges (Fig 1c). Maximum flavour score (8.3) in tomato ketchup was obtained with 0.4% CMC and 1.75% acidity and 10% cooked bottle gourd and 1.5% acidity as acetic acid in comparison to other thickeners for the manufacture of tomato ketchup (Fig 1d and 1b).

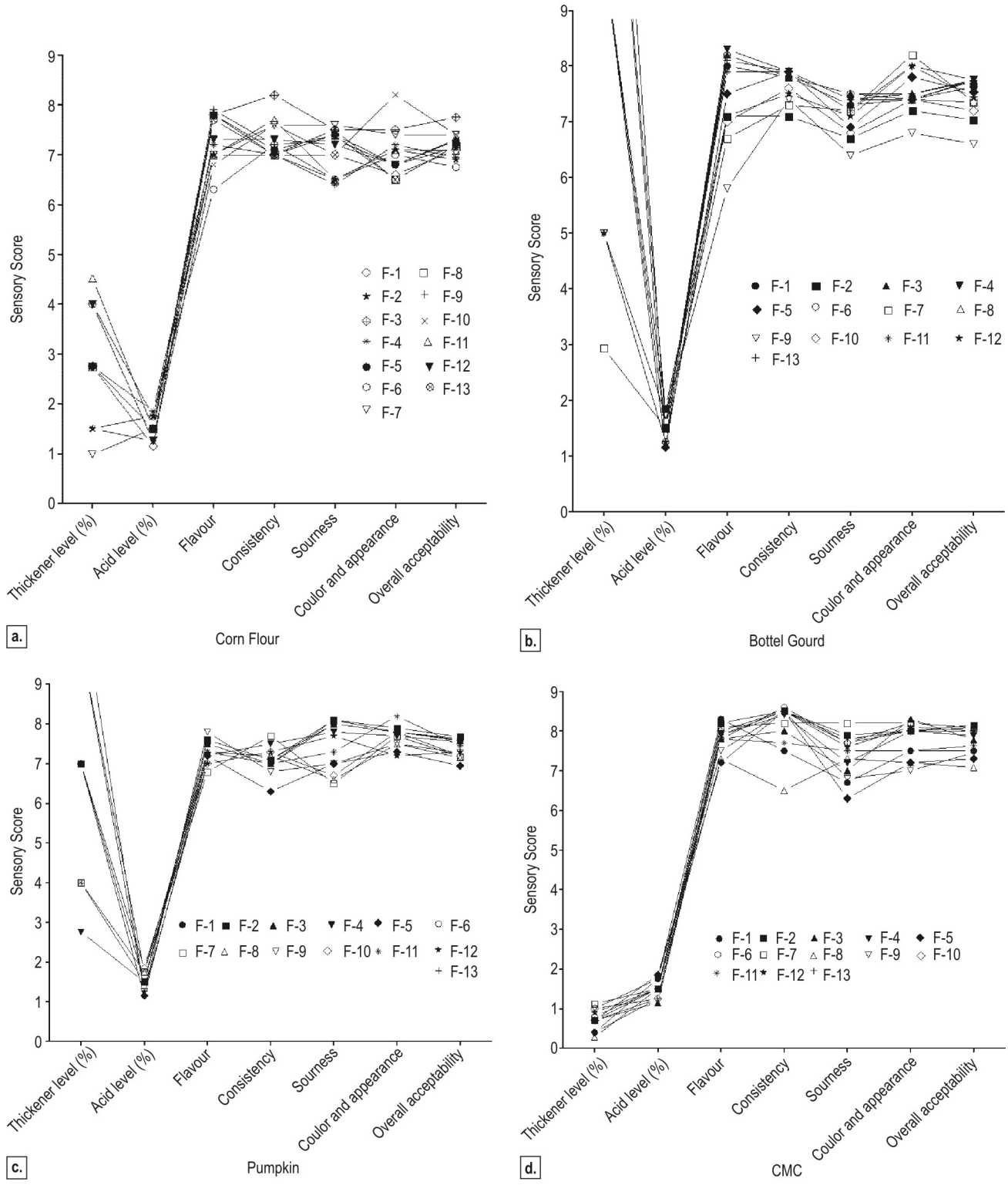

Fig 1 Central composite rotatable design matrix and observed sensory values of response variables in tomato ketchup with different thickeners

Table 1 Physico-chemical properties of tomato ketchup with different thicners

Formulation	Thickener level (%)	Acid level (%)	Total solids (%)	TSS (°Brix)	pH	Serum searation (ml)	Ascorbic acid (mg/100g)	Lycopene (mg/100g)
Corn flour								
1	2.75	1.15	26.8	26.0	4.2	0.0	32.77	0.54
2	1.50	1.75	26.4	26.0	4.0	1.8	29.07	0.25
3	2.75	1.5	27.6	27.0	4.06	0.0	26.96	0.53
4	2.75	1.85	26.4	26	3.96	0.0	39.64	0.77
5	2.75	1.5	26.6	26	4.05	0.0	26.94	0.53
6	4.0	1.75	27	26	3.98	0.0	32.77	1.31
7	0.98	1.5	27.3	27.0	3.97	1.4	47.57	0.24
8	2.75	1.5	26.5	26.0	4.06	0.0	26.87	0.54
9	2.75	1.5	26.6	26.0	4.05	0.0	26.9	0.53
10	1.5	1.25	26.4	26.0	4.11	1.2	34.88	0.23
11	4.52	1.5	26.2	26.0	4.03	0.0	24.31	1.37
12	4.0	1.25	27.2	27.0	4.12	0.0	24.31	0.8
13	2.75	1.5	26.6	26.0	4.06	0.0	26.91	0.53
Bottle gourd								
1	10.0	1.5	27.6	27.0	4.07	2.30	50.74	1.85
2	10.0	1.85	26.8	26.0	4.05	3.0	40.17	1.23
3	10.0	1.5	27.4	27.0	4.07	2.3	50.69	1.89
4	10.0	1.5	26.3	26.0	4.07	2.2	50.71	1.84
5	10.0	1.15	26.7	26.0	4.16	2.6	40.17	1.1
6	15.0	1.25	26.8	26.0	4.16	2.0	45.45	1.54
7	2.93	1.5	27.8	27.0	4.06	2.4	53.91	1.26
8	10.0	1.5	26.4	26.0	4.06	2.3	50.72	1.85
9	5.0	1.75	26.3	26.0	4.06	2.8	57.08	1.5
10	15.0	175	26.5	26.0	4.05	2.2	43.34	1.99
11	17.07	1.5	27.8	27.0	4.13	2.4	44.39	1.5
12	5.0	1.25	27.0	26.0	4.16	2.8	50.74	1.28
13	10.0	1.5	26.8	26.0	4.07	2.30	50.70	1.87
Pumpkin								
1	7	1.5	27.8	27.0	4.07	3.0	42.28	0.75
2	7	1.5	27.7	26.0	4.06	3.0	42.3	0.76
3	7	1.5	27.8	26.0	4.07	3.0	42.29	0.75
4	2.76	1.5	26.2	26.0	4.06	4.0	42.81	0.61
5	7	1.15	27.0	26.0	4.08	3.0	42.28	0.8
6	7	1.5	27.8	27.0	4.07	3.1	42.27	0.74
7	4	1.75	27.8	27.0	4.06	3.4	47.04	0.82
8	10	1.75	26.8	26.0	4.04	3.0	41.75	0.74
9	10	1.25	26.8	26.0	4.16	2.8	52.32	0.91
10	7	1.85	27.6	27.0	4.02	2.6	47.57	0.47
11	4	1.5	26.8	26.0	4.07	3.4	51.79	0.47
12	11.24	1.25	26.4	26.0	4.15	3.0	47.57	0.6
13	7	1.5	27.7	27.0	4.06	3.0	42.31	0.75
CMC								
1	0.4	1.75	26.2	26.0	4.12	0.0	34.35	1.28
2	0.7	1.5	26.3	26.0	4.25	0.0	38.58	1.19
3	0.7	1.15	28.0	27.0	4.32	0.0	38.05	1.02
4	0.7	1.5	26.1	26.0	4.23	0.0	38.6	1.2
5	0.7	185	26.4	26.0	4.19	0.0	34.35	1.08
6	0.8	1.5	26.2	26.0	4.25	0.0	38.48	1.17
7	1.12	1.5	26.3	26.0	4.31	0.0	29.07	0.8
8	0.28	1.5	27.0	26.0	4.19	0.0	35.32	1.12
9	1	1.75	27.2	27.0	4.24	0.0	38.58	1.06
10	1	1.25	26.6	26.0	4.35	0.0	33.3	0.99
11	0.4	1.25	26.8	26.0	4.27	0.0	42.28	1.49
12	0.9	1.5	26.2	26.0	4.24	0.0	38.6	1.20
13	0.7	1.25	26.3	26.0	4.25	0.0	38.63	1.15

However, tomato ketchup with corn flour and cooked pumpkin pulp as thickener was least preferred to judges with minimum flavour score (6.3-7.9 and 6.8-7.8), respectively as compared to tomato ketchup manufactured with cooked bottle gourd and CMC as thickener (Fig 1a and 1c). The corn flour and acid level had shown negative response on the sensory score for flavour, consistency, sourness, colour and appearance and overall acceptability score in tomato ketchup. Similarly the effect of pumpkin as thickener in tomato ketchup had also exhibited negative response on consistency, sourness, colour and appearance and overall acceptability score. There has been no definite response with the use of CMC thickener on sensory score of tomato ketchup. Response surface plot of different thickeners towards sensory score of tomato ketchup had shown better acceptance to the judges in terms of flavour, consistency, sourness and overall acceptability score. There has been mixed response of the judges towards different thickeners and acid level on sensory score in tomato ketchup. However, overall acceptability score showed declining trend in tomato ketchup with increase in corn flour 1.5-4.0%, cooked bottle gourd 5-15%, cooked pumpkin 4-10% and CMC 0.4-1.0% and acid level 1.25-1.75% as acetic acid.

The TSS level in tomato ketchup with different thickeners varied between 26-27% (Table 1). Tomato ketchup manufactured with corn flour, bottle gourd and pumpkin as thickeners had pH values in the range of 3.96-4.2 while tomato ketchup manufactured with CMC stabilizer had higher pH values in the range of 4.12-4.35. It is interesting to observe that vegetable based thickener as bottle gourd and pumpkin in the manufacture of tomato ketchup had produced maximum serum separation of 2.0-4.0 ml while negligible or no serum separation was obtained in tomato ketchup with corn flour and CMC as thickener. Tomato ketchup with vegetable based thickener of bottle gourd and pumpkin contained maximum ascorbic acid (40.17-57.08 and 41.75-52.32 mg/100g), respectively among all the experimental runs whereas the lower ascorbic acid content (29.07-38.63 and 24.31-47.57 mg/100 g) was obtained in tomato ketchup with CMC and corn flour, respectively (Table 1). The higher ascorbic acid content in tomato ketchup with vegetable based thickener of bottle gourd and pumpkin can be attributed with inclusion of vegetable pulp in tomato ketchup. The maximum lycopene (1.1-1.99 mg/100g) as antioxidant was reflected in tomato ketchup with bottle gourd as thickener followed by (0.8-1.49 mg/100g) CMC added tomato ketchup. It can be concluded that acceptable tomato ketchup with different thickeners such as 2.75% corn flour, cooked bottle gourd pulp at 10%, cooked pumpkin pulp at 7% and 0.7% CMC alongwith 1.5% acidity as acetic acid can be developed with good overall acceptability score to consumers. However, CMC as thickener was recognized as best thickening materials in terms of sensory, least serum separation and physico-chemical properties as compared to other thickeners.

SUMMARY

The acceptability of tomato ketchup is dependent on desired mouth feel and acceptable sourness. The acceptable tomato ketchup can be developed with 2.75% corn flour, 7 and 10% of cooked pumpkin and bottle gourd and 0.4% CMC along with 1.5% acidity as acetic acid based on RSM. The vegetable based thickener of bottle gourd and pumpkin in manufacture of tomato ketchup yielded maximum serum separation of 2.2-3.0 ml while negligible serum separation was obtained in tomato ketchup with corn flour and CMC stabilizer. Tomato ketchup with vegetable based thickener of bottle gourd and pumpkin contained maximum (40.17-57.08 and 41.75-51.79 mg/100g) ascorbic acid, respectively among all the formulations.

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