Novel Formulation, Preparation and Quality Evaluation of Sweet Gourd ketchup

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ABSTRACT: This study reports on the possibility or suitability of ketchup preparation using sweet gourd as a base material. The pulp was extracted from mature and sound sweet gourd and subsequently used for preparation of sweet gourd ketchup along with the Carboxymethyl cellulose (CMC) & Starch as a binding agent and other ingredients. The ketchup was prepared by standard formulation. The pulp used in the ketchup preparation was analyzed for proximate composition. Six samples of sweet gourd ketchup containing 0.3-0.7% CMC and 1-3% starch in combination with sweet gourd pulp were prepared. The properties of ketchup were evaluating in terms of moisture content, ash, acidity, vitamin C, TSS and weight. The moisture content of ketchup was increased by the addition of both the thickening agents. However, the rate of increase of moisture content was higher with CMC than that of starch. The ash content and TSS of sweet gourd ketchup was decreased gradually when both higher percentage of starch and CMC were added. Highest ash content was found in control ketchup (1.45%) and lowest was with 0.7% CMC thickened ketchup (1.24%). Acidity was highest in control sweet gourd ketchup and lowest in 0.7% CMC treated sweet gourd ketchup. The weight of sweet gourd ketchup was increased with the increase of both thickening agent. The bacterial count decreased with increased with the increasing level of thickening agents. The ketchup containing different levels of thickening agents were evaluated for their sensory attributes by a panel of 15 tasters. The overall acceptability of the ketchup sample S_5 (0.3% CMC) was found best as compared to other samples.

Keywords: sweet gourd, ketchup, Carboxymethycellulose (CMC), Starch.

INTRODUCTION

Sweet gourd (*Cucurbita moschata*) is an annual herb belonging to the family cucurbitace. It was originated from Central America and Northern South America . Now a days; this plant is grown and accepted as a popular vegetables throughout the entire tropical and sub tropical regions of the world and also in milder portions of the temperate zones of both the hemispheres. It is one of the most important vegetables grown in Bangladesh. Vegetables can play an important role to nutrients to human diet. Sweet gourd is easily digestible and also easy to cook. It is relatively richer source of energy. It contains carbohydrates, minerals, vitamins and higher amount of carotenoid (Bose and Som, 1986). Hence, this crop may solve malnutrition problem of Bangladesh to certain extent particularly to the vulnerable groups, and those are suffering from vitamin - A deficiencies. Sweet gourd has been cultivating in Bangladesh from ancient time as a popular and commercially important vegetables. It is growing extensively in all parts of the country. In the year 2011-2012, Bangladesh produced 165000 metric tons of sweet gourds from nearly 28500 hectares of land. The crop constitutes 10.5% and 8.5% of the total supply

of vegetables in the market during the summer and winter seasons, respectively (BBS, 2011).

Due to plenty supply of sweet gourd during winter and summer seasons, there is a glut in the market resulting in the reduction of demand and prices. Consequently growers face problem to sale their products. Since there are no good facilities for storage, thus large quantities of sweet gourd are spoiled due to its perishable nature. As a result they suffer for economical losses. All this reasons discourage the growers to produce more sweet gourd crop. Hence to resist the reduction of present production and to encourage the growers to produce more, there is no alternative accept to find alternative uses or value addition technology. The suitable preservation method may also prevent this spoilage or wastage of this vegetable and may make available the throughout the year. Moreover, this will stimulate to increase production, bring better returns to the farmers and improve nutritional status of the peoples. So far, it is known that the standard procedures for processing of sweet gourds for ketchup production are meagre. Sometimes are processed traditionally to prepare Halua, Ketchup, Jam, Jelly, Candy, Toffee, Morobba etc at home level. Among the various sweet gourd products ketchup could be prepared at industrial level as it requires simple methods and inexpensive machineries.

In ketchup, sometimes thickening agents are used. Thickening agents are natural or chemically modified carbohydrates that absorb water and, thereby making the food thicker. Thickening agents stabilize foods by mixing oil, water, acids and solids etc. Commonly used thickening agents are starch, carboxymethylcellulose (CMC), guar gum, flour paste, arrowroot, split peas etc. Starches can assume a multifunctional role in ketchup. It provides viscosity and helps the particle for consistent suspension and clarity. Methylcellulose and hydroxypropyl methylcellulose can increase product viscosity at higher temperatures, but the product liquefies upon cooling, making those excellent products such as barbecue sauce, pumpkin ketchup. In spite of various efforts mentioned above, no elaborate work has been reported so far on sweet gourd ketchup preparation in Bangladesh. This experiment was, therefore, conducted to pursue the following objectives: a) To study the feasibility of ketchup production using sweet gourd as a base material. b)To find out a suitable formulations for sweet gourd ketchup. c) To study the effects of carboxymethylcellulose (CMC) and starch on the quality and acceptability of sweet gourd ketchup. d) To study the shelf- life of prepared sweet gourd ketchup.

2. MATERIALS AND METHODS

2.1 Materials

Sweet gourd *(Cucurbita moschata)* used in the studies were collected from market. Only ripe and fresh Sweet gourd was used in this study. Other materials such as carboxymethylcellulose (CMC), starch, sugar, salt, spices, glass bottle and chemicals etc. for the experiments were collected from the laboratory stock.

2.2 Methods

2.2.1 Preparation of Sweet gourd pulp

The fully matured, sound, and fresh Sweet gourd were peeling thoroughly. All the seeds and cavities and yellow portions if any were removed from the sweet gourd meat. Then they were cut into small pieces and boiled for about 20 minutes and crushed with wooden ladle to extract maximum pulp. The pulp was also extracted from the left over crushed materials.

2.2.2 Product development

2.2.2.1 Formulation of ketchup

The formulation of sweet gourd ketchup is outlined in Table 1. The basic formulation was adopted from Srivastava (2002) as like tomato ketchup.

Table 1. Formulations of sweet gourd Ketchup

Ingredients	Formulations
	Sweet gourd Ketchup
pulp	3Kg
Onion (chopped)	37 g
Garlic	2g
spices(Cardamon,black pepper)	1.2 g
Cinnamon	1.8 g
Red chillies	1.5 g
Close whole (deheaded)	1 g
Salt	15g
Sugar	140 g
Vinegar	150 ml
Sodium benzoate	700 mg/kg

2.2.2.2 Processing of Sweet gourd

Preparation of Ketchup

The measured amounts of sweet gourd pulp were taken in stainless steel vessels. The measured spices were mixed and bagged in a cheese cloth and tied tightly termed as spices bag. The pulp vessel was then placed in a heater and the spices bags were put into the pulp. Heat with gentile stirring. One third quantity of measured sugar and salt were added and mix thoroughly. Thickening agent were added before boiling pulp and stirred thoroughly for mixing. Heating and boiling continued till. The pulp reduced to one-third of its original bulk. In case of using CMC as a thickening agent the measured amount will be soaked in water for 24 hrs before using. After boiling the pulp, the spices bag was removed and squeezed to extract its essence to the boiling mass. Then added the remaining quantity of sugar, salt and vinegar were then added and mixed thoroughly. Heated the mixed materials till the required consistency was reached. It is indicated sometimes by measuring total soluble solid of the boiling mass.

The measured amount of sodium benzoate was added to a small quantity of the ketchup and solubilised, then added to finished product and mixed thoroughly. The finished product was poured into sterilized bottle of 150 gm capacity and then sealed. The bottles with the contents were sterilized in boiling water for 20 minute. Cooled the bottles in air and then stored in a cool, dry place.

All the treated samples of ketchup stored at room temperature (30°C) for a period of 6 Month and analyzed for chemical composition, bacterial load count, sensory taste and visual observation for mold or fungus growth at an interval of 30 days. Flow sheet for manufacture of sweet gourd ketchup is shown in Fig. 1.

2.2.3 Analysis of sweet gourd pulp and sweet gourd ketchup

The fresh sweet gourd pulp and finished product of Sweet gourd ketchup analyzed for moisture content, ash, acidity, vitamin C, total soluble solids (TSS), pH, sugar, protein, crude fiber .

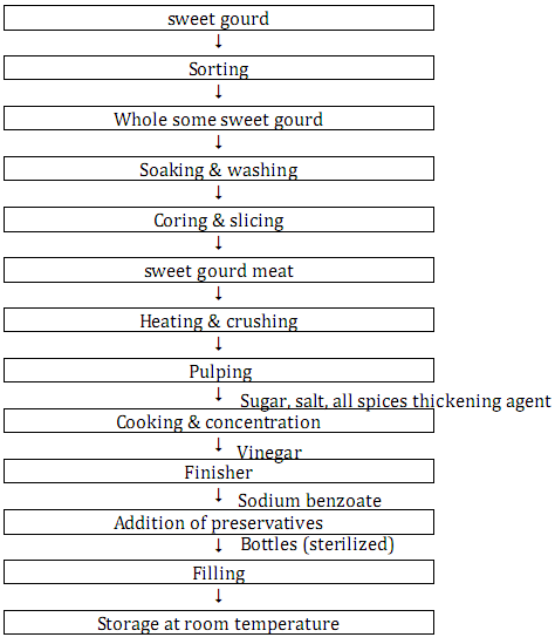

Fig. 1. Flow sheet for preparation of sweet gourd ketchup

For Sample S_1 – S_7 different formulation was used. (Table 2.)

Ingredients	Formulations						
	Control (without thickness) Sample S_1	Sample S_2	Sample S_3	Sample S_4	Sample S_5	Sample S_6	Sample S_7
Sweet gourd pulp (kg)	3	3	3	3	3	3	3
Thickening agent (% of pulp)	0	1 starch	2 starch	3 starch	0.3 CMC	0.5 CMC	0.7 CMC
Onion (chopped) (g)	37	37	37	37	37	37	37
Garlic (g)	2	2	2	2	2	2	2
spices(Cardamon, black pepper) (g)	1.2	1.2	1.2	1.2	1.2	1.2	1.2
Cinnamon (g)	1.8	1.8	1.8	1.8	1.8	1.8	1.8
Red chillies (g)	1.5	1.5	1.5	1.5	1.5	1.5	1.5
Close whole (deheaded) (g)	1	1	1	1	1	1	1
Salt (g)	15	15	15	15	15	15	15
Sugar (g)	140	140	140	140	140	140	140
Vinegar (ml)	150	150	150	150	150	150	150
Sodium benzoate (mg/kg)	700	700	700	700	700	700	700

Table 2: Formulations of Sweet gourd ketchup using starch and CMC thickeners

2.2.3.1 Moisture

Moisture content was determined adopting AOAC (1984) method.

First of all, weight of empty previously dried (1 hr at 100 ^{0}C) crucible with cover was taken and 10 gm of sample was placed on it. Then the crucible was placed in an air oven (thermostatically control) and dried at a temperature of 100 to 105 ^{0}C for 24 hrs. After drying, the crucible was removed from the oven and cooled in desiccator. It was then weighed with cover glass. The crucible was again placed in the oven, dried for 30 minutes, took out of the dryer, cooled in a desiccator and weighed. Drying, cooling and weighing were repeated until the two consecutive weights were the same. From these weights the percentage of moisture in food sample was calculated as follows:

$$\% \text{ moisture} = \frac{\text{Loss in weight}}{\text{Weight of sample}} \times 100$$

2.2.3.2 Protein

Protein content was determined using AOAC (1975). The accepted method was as follows:

Reagent required:

1. Concentrated H_2SO_4 (Nitrogen free),
2. Digestion mixture:
   - Potassium sulphate = 100 g,
   - Cupper sulphate = 10 g and
   - Selenium di- oxide = 2.5 g well mixed in a mortar and kept in a dry place.
3. Boric acid solution = 2.0 % solution in water,
4. Alkali solution = 400 g NaOH in water and diluted to one liter,
5. Mixed indicator solution = Bromocresol 0.1 g and Methyle red 0.2g dissolved in 250 ml ethyl alcohol.
6. Standard HCl = 0.1 N

Procedure

Two gram sample was taken in a 250 ml of Kjeldahl flask. 2 g of digestion mixture was added with the sample. 25 ml of concentrated sulfuric acid was added for oxidation. The flask was placed in an inclined position on the stand in digestion chamber, heated continuously until frothing ceased and then simmered briskly. The solution became clean in 15- 20 minutes,

continued heating for 45 minutes. After cooling, 100 ml water was added and transferred quantitatively to a one liter round bottom flask; the final volume was about 500 ml. Added gently down the side enough NaOH solution to form a precipitate at cupric hydroxide and immediately connected the flask to stream- trap and condenser. To a 500 ml conical receiving flask 50 ml of boric acid solution, 50 ml distilled water and 5 drops of indicator solution were added. Positioning the condenser distillation was carried out for 40 to 45 minutes or until about 200 ml of distillate was obtained. The contents of the receiving was filtrated with hydrochloric acid, the end point was marked by a pink colour. A reagent blank was also determined and deducted from the titration.

One ml of 0.1 N HCl acid contain = 0.0014 gm of N_2. A protein conversion factor of 6.25 was used to calculate the percent protein from nitrogen determination. Percentage of nitrogen and protein calculated by the following equation:

$$\% \text{ Nitrogen} = \frac{(T_s - T_b) \times N \text{ of acid} \times 14 \times \text{vol}^{m} \text{ made of digestion} \times 100}{\text{Weight of sample} \times \text{Aliquot of digestion taken} \times 1000}$$

Where,

T_s = Titer volume of the sample (ml)

T_b = Titer volume of the blank (ml)

% Protein = Nitrogen × 6.25

2.2.3.3 Ash

AOAC method (1984) was used to determine the total ash content. Samples (2 to 3 gm) were weighed into clean dry porcelain ashing dishes previously ignited at 600°C for several hours, cooled in desiccators and weighed. The sample was then placed in a muffle furnace at 550°C and ignited until light gray ash resulted (or to constant weight). The sample was then cooled in desiccators and weighed. The ash content as expressed as:

$$\% \text{ Ash} = \frac{\text{Weight of residue}}{\text{Weight of sample}} \times 100$$

2.2.3.4 Crude fibre

Crude fibre was determined according to AOAC method (1984). The method was as follows:

Reagent required: 0.255N sulphuric acid solution (i.e. 1.25 g H_2SO_4/100 ml water); 0.313N sodium hydroxide solution (i.e. 1.25 g NaOH/100 ml water); 10.0% Potassium sulphate solution; Asbestos-Gooch grade.

Procedures: Two gram **(**2gm) sample remaining after crude fat determination was taken and transferred to the digestion flask with approximately 0.5 gm asbestos. Added 200 ml of boiling sulphuric acid solution and immediately was connected the digestion flask with lei big condenser and was boiled briskly for 30 min. During digestion care was taken to keep material remaining on the sides of the digestion flask without contact with solution. After completed the boiling, the flask was removed and filtrated through linen in a fluted funnel and washed with boiling water until the washings are no longer acid. Heated sodium hydroxide solution to boiling under reflux condenser and washed the residue from acid digestion back into the flask with 200 ml of boiling sodium hydroxide solution and connected the flask with reflux condenser and boiled for exactly 30 min. After 30 min. of boiling the flask was removed and immediately filtered through filtering cloth in a fluted funnel washed with water and potassium sulphate solution. Returned the residue to the digestion flask thoroughly washing all residues from cloth with hot water. Filtered into the Gooch crucible prepared with thin but a packed layer of ignited asbestos.

After washing of the residue in the Gooch crucible with boiling water, washing was repeated with approximately 15 ml of alcohol. The crucible with the contents was dried at 110°C to constant weight and then cooled in a desiccators and weighed. Ignited the contents of the crucible in an electric muffle furnace at dull red heat (550^0 C) until carbonaceous is destroyed (approximately 20 min). Cooled in a desiccators and again was weighed. The loss in weight represents crude fibre.

$$\% \text{ Crude fiber} = \frac{\text{Loss in weight noted}}{\text{Weight of sample taken}} \times 100$$

2.2.3.5 Titrable acidity

Titrable acidity was determined according to

AOAC method (1984). The method was as follows:

Ten gram (10gm) sample was taken in a blending machine and homogenized with distilled water. The blended materials were then filtered and transferred to a 250 ml volumetric flask and the volume was made up to the mark with distilled water 5 ml of solution was taken in a control flask and titrated with 0.1 N NaOH solution just below the end point, using phenolphthalein as indicator. The titration was done for several times for accuracy. Percent titrable acidity was calculated using the following formula:

$$\% \text{ Titrable acidity} = \frac{T \times N \times V_1 \times E}{V_2 \times W \times 1000} \times 100$$

Where,

T =Titration

N = Normality of NaOH

V_1 = Volume made up

E = Equivalent weight of acid

V_2 = Volume of extract taken for estimation and

W = Weight of sample

2.2.3.6 Vitamin C content(Ascorbic acid**)**

Ascorbic acid was determined following the method of Rangana (1977). The method was as follows:

The reagents used for the estimation of vitamin C were as follows:

i) Metaphosphoric acid (3%)

ii) Standard ascorbic acid solution

iii) 2-6 dichlorophenol iendophenol dye

For estimation of Vitamin C, the following steps were followed:

Standardization of dye solution

Five ml standard ascorbic acid solution was taken in a conical flask and 5 ml metaphosphoric acid (HP03) was added to it and then shaken. A micro-burette was filled with dye solution and the mixed solution was titrated with dye using phenolphthalein as indicator. Dye factor was calculated using the following formula:

$$\text{Dye factor} = \frac{0.5}{\text{Titre}}$$

Preparation of sample

Ten gm (10gm) sample was taken in a blender machine and homogenized with 3% metaphosphoric acid and then the blender materials were filtered. The filtrate was transferred to a 250 ml volumetric flask and the volume was made up to the mark with metaphosphoric acid.

Titration

Five ml (5ml) of metaphosphoric acid extracted sample was taken as an aliquot and titrated with standard dye solution, using phenolphthalein indicator. Vitamin C content was calculated by using the following formula:

Vitamin C content (mg per 100 gm sample)= $\frac{T \times D \times V_1}{V_2 \times W} \times 100$

Where,

T = Titration

D = Dye factor

V_1 = Volume of made up

V_2 = Volume of extract taken for estimation

W = Weight of sample taken for estimation

2.2.3.7 Total soluble solids (TSS)

A total soluble solid was estimated by using Refractometer (Model no. 8987 Puji Kuki Ltd. Tokyo, Japan). A drop of sample of the sweet gourd ketchup was placed on the prism of the Refractometer and per cent total soluble solids were obtained from direct reading. Temperature correction was made as described by Rangana (1977).

3.2.3.8 pH

An electrolytic cell composed of two electrodes (caramel and glass electrode) was standardized with buffer solution of pH = 4.0. Then the electrodes were dipped into the test. sample. A voltage corresponding to the PH of the solution was developed and directly one can read the PH of the solution indicated by the instrument (potentiometer).

2.2.3.9 Sugar

Sugar was determined following the method of Rangana (1977). Sugar content was estimated by determining the volume of unknown sugar solution of sweet gourd ketchup required for complete reduction of standard Fehling's solution. The following procedures were followed in determining sugar content.

Standardization of Fehling's solution

Ten nits of both Fehling's solution A and Fehling's solution B were mixed together in a beaker. Ten nil of mixed solution was pipetted

into a 250 ml conical flask and 25 ml distilled water was added to it. Standard sugar solution was taken in a burette. The conical flask containing mixed solution was heated on a hot plate. When the solution began to boil, three drops of methylene blue indicator solution was added to it without removing the flask from 1 kg hot plate. Mixed solution was titrated by standard sugar solution. The end point was indicated by decolorization of the indicator. Fehling's Factor was calculated by using the following formula:

Titre x 2.5 Fehling's Factor (gm of inverts sugar)

$$= \frac{\text{Titre} \times 2.5}{1000}$$

Preparation of sample

Mixed 25 gm of sweet gourd ketchup with 100 ml of distilled water and 5 ml of neutral lead acetate solution and kept for 10 minute and homogenized. Then the blended material was transferred to a 250 ml volumetric flask. The volume was made up to the mark with distilled water. The solution was filtered.

Titration of reducing sugar

Ten ml (10ml)of mixed Fehling's solution was taken in a 250 ml conical flask and made 250 ml with distilled water. Purified juice solution (filtrate) was heated on a hot plate. Three to five drops of methylene blue indicator were added to the flask when boiling started and titrated with solution taken in the burette. The end point was indicated by the decolorization of indicator. Percent reducing sugar was calculated according to the following formula:

$$\% \text{ Reducing sugar} = \frac{F \times 100}{T \times W}$$

Where,
F = Fehling's Factor Dilution
T = Titre, and
W = Weight of sample

2.2.4 Microbiological studies

The microbiological studies were done in the laboratory of the Department of Food Technology and Rural Industries, Bangladesh Agricultural University, Mymensingh.

2.2.4.1 Bacterial plate counts:

Methods and technique are followed as described by Rangana (1977). Microbiological studies are confined within the microbial load count only. Total viable bacterial count was done through the Standard Plate Count technique (Pour Plate Method).

2.2.4.2 Sample preparation:

The reliability of the analysis and interpretation of the results depend largely on the correct manner in which the sample is taken. The sample should be a true representative of the whole mass. For this put-pose the product is thoroughly well mixed so that the sample would be the representative of the whole mass of the products. 25g of this well mixed ketchup were taken in 250-ml flask. Phosphate buffer dilution water (0.6 mM KH_2PO_4, pH 7.2) was used for dilution of the sample. About 100 ml of the buffer water was added to the beaker and mixed well by up-and-down or to-and-fro movement. The volume made up with the same buffer water. All the apparatus, solutions and other tools used should be sterilized i.e. heated at 121°C for 15 minutes. The prepared sample was now become diluted to 10 times i.e. $1x10^{-1}$ times dilution and used as stock solution.

2.2.4.3 Dilution:

A series of dilution were made as follows using 9 nil blanks.

a) The initial $1/_{10}$ dilution (1 ml in 9 ml) was performed

b) This was mixed in a vortex mixer

c) 1 ml from (b) was taken, added to the next tube and mixed well. It was become 10^{-2} time's dilution

d) 1 ml from (c) was taken, added to next 9 ml tube and mixed well. It was then become 10-3 time's dilution.

In this way, the dilution was made up to 10^{-6} times. The scheme is shown as in Fig. 2

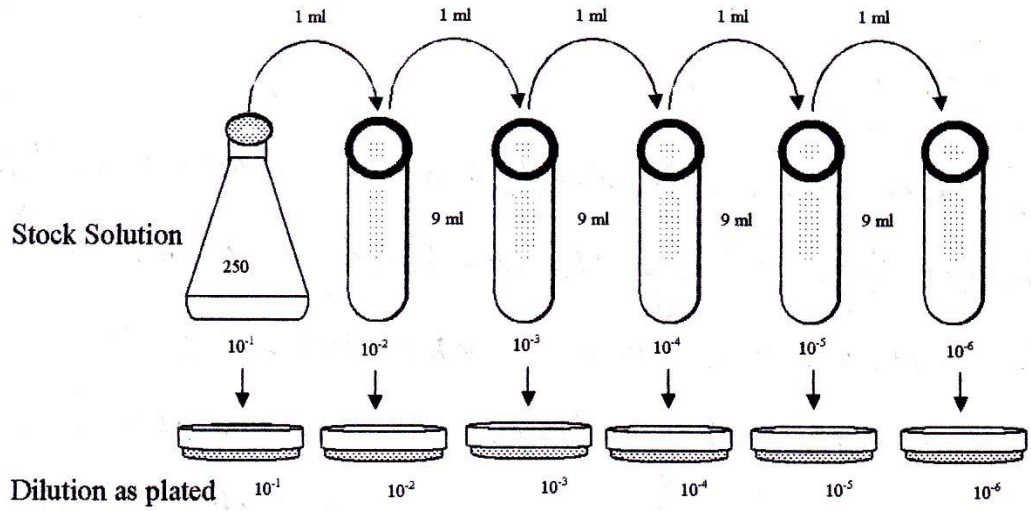

Fig. 2: Simple serial dilution series using 9 ml blanks and plating.

2.2.4.4 Standard plate counts (SPC):

A SPC (or aerobic plate count [APC]) is used to determine the level of microbes in the prepared and stored ketchup. This data could be used as the indicators of food quality or predictors for the shelf life of the ketchup. 1 ml of the diluted sample was then pipette into each of the sterile empty Petri dishes having nutrient agar media (approximately 10-20 ml) at a temperature of 45°C. The plates were mixed by swirling on a flat surface. Each dilution was plated in triplicate. After solidification of the media the plates were inverted and incubated at 37°C for 24 hrs in an incubator.

2.2.4.5 Counting and recording:

After incubation the incubated plates were selected for counting the bacterial colony based on the number and easy of counting of the colony. The plate containing segregated, overlapping and confusing colonies was avoided. The plates containing 30 to 250 bright, cleared and countable colonies were selected.

Number of colony forming unit (cfu)/g or m1. = average cfu/plate x dilution factor

Sensorial observations for spoilage and growth of mold/fungi were done throughout the storage period. The viable bacterial count was done passing through the steps of sample preparation, sample dilution. Standard plate counts counting and recording. The incubation was performed at 37°C for 24 hr.

2.2.4.6 Counting of Yeast and mould

Yeast and mould count of sweet gourd products were also determined according to the "Recommended Method for the Microbiological Examination of Food", Published by American Public Health Association (APHA, 1967).

Preparation of dilution blanks

Dilution blanks was prepared for counting yeast and mould using similar procedure followed as in case of preparation of dilution blanks for counting bacteria mentioned earlier (Potato Dextrose Agar media was used in preparation of dilution blanks).

Making of dilution and procedures of planting

Making of dilution and procedures of planting for counting yeast and mould was done as per making of dilution and procedures of planting for counting bacteria except for the media Potato Dextrose Agar.

Incubation for colony counting

After solidification of agar, the plates were inverted and incubated at 250 ^{0}C for 3 days. After incubation, the plates were taken out from the incubator and colonies were counted. Finally, the colony number was multiplied by the dilution and the counts per gram of sample were recorded.

2.2.5 Sensory evaluation of Sweet gourd ketchup

The results were evaluated by analysis of variance (ANOVA) and Duncun's Multiple Range Test (DMRT) procedures of the statistical analysis system (SAS, 1985)

The symmetry and the characteristics of sweet gourd ketchup prepared from different percentage of thickening agent (starch, CMC and control ketchup were evaluated for color, flavor, texture and overall acceptability through a testing panel. The panelists were selected from the teachers, students and employers of the Department of Food Technology and Rural Industries. Prepared ketchup was coded as S_1, S_2, S_3, S_4, S_5, S6 and S_7 for evaluation. Little amount of sweet gourd ketchup was presented to panelists and asked to differentiate the samples according to their preference in respect of color, flavor, texture and overall acceptability of the sample. Preference will be made through score point. The score points were selected as follows:
9 = Like extremely; 8 = Like very much; 7 Like moderately; 6 = Like slightly; 5 = Neither like nor dislike; 4 = Dislike slightly; 3 = Dislike moderately; 2 = Dislike very much and 1 = Dislike extremely.

The score points were tabulated and analyzed statistically for finding the difference & preference of the sample formulation.

2.2.6 Statistical analysis

Experiments were performed in triplicate and the results were expressed as mean ± SD. The statistical analysis was carried out by using SPSS 17.0, and Microsoft Excel 2007. A value of $P < 0.05$ was considered to indicate statistical significance.

RESULTS AND DISCUSSIONS

3.1 Composition of Sweet gourd meat

The Sweet gourd meat was analyzed for general composition. The Sweet gourd pulp contained moisture content 90.6%, Dry matter 9.4 %, ash content 0.72%, ascorbic acid (vitamin C) 3.10 mg/100g, pH 5.92, Acidity 0.17%, reducing sugar 8.68% and Non-Reducing sugar 0.0%. The results of the present work showed a negligible variation with the results of some other workers. This variation may be due to mechanical or inefficient determination. The difference may also be contributed by sweet gourd varietals difference, soil condition and its nutritional status of along with the climatic condition.

The composition of sweet gourd under study was more or less similar to those reported by following other workers. Composition of this Sweet gourd pulp was almost similar to the findings of Lodh and Dutta, (1974). She reported that Sweet gourd pulp contained 93.1 % moisture, 8.0 mg/100gm Vitamin C, reducing sugar 3.1%, acidity 0.14%and Dry mater 6.0 %. Goplan *et al.* (1982) proposed the moistuer content of fresh sweet gourd to be 92.6% which is very close to 90.6 %. Choudhury (1967), and Goplan *et al.* (1972) observed the Vitamin-C content of fresh sweet gourd was 2.0 mg per 100 gm sample which is near about our observation.

3.2 Analysis of chemical composition of sweet gourd ketchup

Sugar based concentrated sweet gourd ketchup were prepared by mixing various ingredients according to formulation (Srivastava, 2002).The chemical composition of sweet gourd ketchup were determined after complete preparation of sweet gourd ketchup.

The sweet gourd ketchup was analysis for chemical composition which is shown in Table 3.

Table 3: Chemical composition of sweet gourd ketchup

Parameters	Sweet gourd ketchup
Moisture content (%)	74.95
Total soluble solid (TSS %)	25
Acidity (%)	0.55

pH	4.05
Vitamin C (mg/100 gm)	1.20

In this study it was observed that the TSS of sweet gourd ketchup was 25% which is similar to TSS of tomato ketchup. Firstly, the TSS of fresh sweet gourd pulp was 9.4%. However TSS of the final product increase due to addition of sugar and salt to the ketchup formation and evaporation of moisture from the ketchup formulation during prolong heating for desired consistency (about 22-25% TSS). Srivastava and kumar (2002) stated that minimum total soluble solid (%) of tomato ketchup should be 25%. In all cases; acidity and pH of sweet gourd ketchup were similar to tomato ketchup.

3.3 Effect of starch & CMC as thickening agent on composition of sweet gourd ketchup

3.3.1 Composition of sweet gourd ketchup

The proposed ketchup was analyzed for moisture, ash, ascorbic acid, total soluble solid, acidity and pH content. The compositional constituents were prepared in Table 4. The table showed that moisture content of sweet gourd ketchup prepared without thickening agent (control), different level of starch(1-3%) and CMC (0.3-0.7%) used as thickening agent were decreased with added of a starch & CMC concentration. The thickening agent starch and CMC absorbed water acts as a water binding agent during swelling and gelatinization phenomena on heating and processing. Thus consequently the desired consistency of the ketchup obtained at lesser processing and heating time compared to the ketchup prepared without any starch and CMC addition. So, moisture cannot be evaporated easily in the case of starch and CMC thickened ketchup.

Ash content and acidity of sweet gourd ketchup were decreased with the increased of level of starch and CMC. Highest value of ash content was found in control ketchup (1.45%) and lowest was found with ketchup having 3% starch (1.24%). The probable reason of these results may be explained as the starch do not contain any soluble mineral salts but contribute to increase the weight of dry matter.

It is also observed that total soluble solid increased with increasing level of starch and CMC. This may be explained as the certain portion of the added starch and CMC may go on solution on prolong heating at high temperature during the preparation of sweet gourd ketchup.

From Table 4. Vitamin-C was found less in sweet gourd ketchup by treated with starch and CMC. The reduction was found in ascending orders of thickening agent addition. The explanation of the result may be due to higher weight of ketchup contributed by the thickening agents. The reduction also may be due to prolong heating because vitamin C is sensitive to heat, light and oxygen.

Table 4: Effect of thickening agents on the compositional constituents of sweet gourd ketchup

Compositional components of ketchup	Treatments						
	Control	Starch			CMC		
		1%	2%	3%	0.3%	0.5%	0.7%
Moisture	75.1	74.40	73.6	72.6	74.30	73.70	72.7
Ash (%)	1.45	1.35	1.30	1.28	1.38	1.32	1.28
Acidity (%)	0.55	0.50	0.46	0.42	0.50	0.45	0.40
Vitamin C (mg/100 gm)	1.20	1.0	0.89	0.78	0.98	0.87	0.76
TSS	25.0	25.60	26.4	27.4	25.70	26.30	27.30
Protein	1.43	1.33	1.31	1.26	1.37	1.30	1.24
Fiber	1.20	1.13	1.07	1.0	1.1	1.04	0.99

Protein and fiber content of prepared ketchup was determined. The result shown in Table 4. It was observed that higher amount of protein and fiber present in ketchup prepared without

addition of thickening agent. The amount of protein and fiber content decreased with the addition of thickening agent (Starch & CMC).It may be for the application of thickening agent which contributed the weight of prepared ketchup but it did not contribute any protein and fiber. Since protein and fiber remaining constant and weight is increasing, hence the amount of protein and fiber per unit weight of ketchup decreased. Also from Table 4. it was found that the highest fibre content 1.2% and protein content 1.43% for the control condition.

3.4 Effect of Storage time on the compositional components of sweet gourd ketchup

Storage studies were done for 180 days. Acidity of sweet gourd was measured at an interval of 30 days during 180 days storage. Result shown in Table 5. The negligible changes of acidity was found during 180 days storage at room temperature may be due to the fermentation or hydrolysis of added sugar in the formulated ketchup.

Table 5: Effect of storage time on acidity of sweet gourd ketchup

Samples	Acidity						
	Storage in Month						
	0	1	2	3	4	5	6
S_1	0.55	0.55	0.56	0.562	0.57	0.58	0.59
S_2	0.50	0.50	0.51	0.519	0.52	0.53	0.55
S_3	0.46	0.46	0.47	0.478	0.49	0.50	0.51
S_4	0.42	0.42	0.43	0.44	0.44	0.45	0.46
S_5	0.50	0.509	0.51	0.51	0.52	0.53	0.53
S_6	0.45	0.456	0.46	0.47	0.48	0.49	0.50
S_7	0.40	0.40	0.41	0.42	0.43	0.44	0.45

Table 6. showed that TSS of all sample were not affected during 180 days storage. Some sample showed negligible changes which may be mechanical or instrumental error. Since there was no scope to evaporate the moisture form concentrate sweet gourd ketchup after bottling and capping, hence the TSS was supposed to remain unchanged during storage period at room temperature.

Table 6: Effect of storage time on TSS of sweet gourd ketchup

Samples	TSS						
	Storage in Month						
	0	1	2	3	4	5	6
S_1	25.0	25.0	25.0	25.0	25.1	25.0	25.1
S_2	25.6	25.6	25.5	25.6	25.6	25.5	25.6
S_3	23.9	23.9	23.9	23.9	23.92	23.9	23.92
S_4	27.4	27.4	27.3	27.4	27.4	27.3	27.3
S_5	24.9	24.9	24.8	24.8	24.91	24.9	24.92
S_6	26.3	26.3	26.4	26.3	26.4	26.41	26.41
S_7	27.3	27.31	27.31	27.3	27.32	27.32	27.31

The situation of Vitamin-C has been shown in Table 7. Remarkable changes were observed during storage. When the ketchup was prepared, the vitamin-C was very minor due to high temperature for evaporation of moisture. Vitamin-C was also changed during storage due to high sensitivity by time and temperature.

Table 7: Effect of storage time Vitamin C (mg/100gm) of sweet gourd ketchup

Samples	Vitamin C (mg/100gm						
	Storage in Month						
	0	1	2	3	4	5	6
S_1	1.2	1.12	1.05	0.95	0.9	0.82	0.72
S_2	1.0	0.97	0.93	0.9	0.86	0.81	0.76
S_3	0.89	0.83	0.75	0.7	0.67	0.63	0.60
S_4	0.78	0.73	0.70	0.66	0.61	0.55	0.51
S_5	0.98	0.94	0.82	0.75	0.7	0.63	0.58
S_6	0.87	0.84	0.81	0.77	0.73	0.69	0.65
S_7	0.76	0.73	0.70	0.66	0.62	0.58	0.54

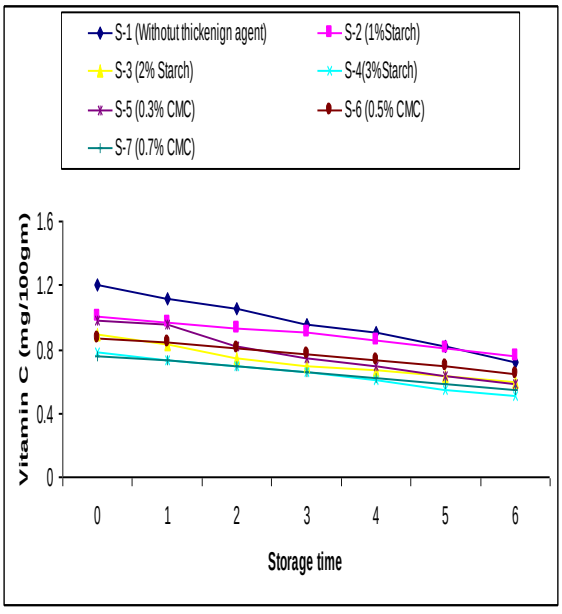

Fig.1 : Changes of vitamin C during storage period

From Table 8, it was observed that during storage period reducing sugar of sweet gourd ketchup slightly increased in all sample condition (control, starch and CMC). Also the value of reducing sugar increase with the increasing level of both starch & CMC, because thickening agent prolong heating process along with breakdown of sugar in the presence of citric acid.

Table 8: Effect of thickening agent on reducing sugar of Sweet gourd ketchup

Sample no.	Reducing sugar (%) in Month				
	0	1	2	3	4
Control (sample S_1)	12.10	12.38	12.65	12.78	12.95
1% starch (sample S_2)	12.60	12.96	13.12	13.36	13.52
2% starch (sample S_3)	12.96	13.56	13.7	13.96	14.1
3% starch (sample S_4)	13.40	13.56	13.78	13.96	14.10
0.3% CMC (sample S_5)	12.70	12.85	13.0	13.28	13.57
0.5% CMC (sample S_6)	12.92	13.10	13.28	13.50	13.68
0.7% CMC (sample S_7)	13.30	13.48	13.66	13.78	14.1

3.5 Effect of thickening agent on weight of Sweet gourd ketchup

Form the Table 9, it was observed that the weight of sweet gourd ketchup significantly influenced by addition of the thickening agent and increased the total weight remarkably. In control ketchup the weight was found about 1149 gm. But the thickening agent of starch in 1%, 2% and 3% and CMC in 0.3%, 0.5% and 0.7% the weight was found 1310 gm, 1395 gm, 1450 gin, 1210 gm 1320 gm and 1470 gin respectively. From Table 9, it was also found that the 0.7% gives the highest weight in all samples, as CMC is more active thickening agent than starch and in the sample percentage of CMC is high.

Table 9: Effect of thickening agents on weight of Sweet gourd ketchup

Weight	Sample						
	S_1	S_2	S_3	S_4	S_5	S_6	S_7
Gram	1149	1310	1395	1450	1210	1320	1470

3.6 Microbial Study of Sweet gourd ketchup

3.6.1 Effect of total viable bacteria on different levels of thickening agent of Sweet gourd ketchup

This study was conducted by standard plate count (SPC) method. After 48 hours of incubation, colonies developed were counted. The total number of viable bacteria present in sweet gourd ketchup was not similar. The total number of viable bacteria per ml of original sample was obtained by multiplying the number of colony forming units (cfu) on the plate with respective dilution factor. Then it converted into logarithainic form. The counting total number of viable bacteria in different sample is shown in Table 10. The result shows that bacterial count decreased with increase of thickening agent. But the increasing rate was not similar. The result also showed that bacterial count increased with the storage time. From the Table 10. the lowest score was observed in sample S_7, (control ketchup), highest score was in sample S_1 (Control) and other samples are almost same. However, CMC thickened sweet gourd ketchup contained slightly lower bacterial count than starch. So, it was proved that, CMC is more effective than starch against microbial growth. Again, the Table 10. showed that viable bacterial count increased proportionally with the increasing of storage period. From the above discussion it is clear that the total viable bacterial count decreased with the increase of thickening agent also with storage period.

Table 10: Effect of growth of total count of bacteria (log cfu/ml) at different levels of thickening agent of sweet gourd ketchup

Sample No	After 2 Month				After 4 Month			
	No of Colony	Dil^n No.	No. of Total Bacteria	Total count (Log.cfu/ml)	No of Colony	Dil^n No.	No. of Total Bacteria	Total count (Log.cfu/ml)
S_1	38	2	38 ×10^2	3.57	48	3.57	48 ×10^2	3.68
S_2	31	2	31 ×10^2	3.49	41	2	41 ×10^2	3.61
S_3	27	2	27 ×10^2	3.43	38	2	38 ×10^2	3.57
S_4	23	2	23 ×10^2	3.36	35	2	35 ×10^2	3.54
S_5	26	2	26 ×10^2	3.41	37	2	37 ×10^2	3.56
S_6	24	2	24 ×10^2	3.38	33	2	33 ×10^2	3.51
S_7	18	2	18 ×10^2	3.25	36	2	36 ×10^2	3.55

3.6.2 Effect of mould and yeast on different levels of thickening agent of Sweet gourd ketchup

Mould and yeast in the sweet gourd ketchup were not similar. Mould and yeast were found in sweet gourd ketchup have been shown in Table 11.

During the experiment there was no countable yeast present in sweet gourd ketchup. The maximum mould was found in sample S_4 (4% starch) and less amount of mould was found in ample S_1 (control) which are shows in Table 11. Samp1e, S_2, S_3, S_5, S_6, and S_7 were almost same, which were higher than S_1 and lower than S_4. So, it was noted that there was slight effect of thickening agent on sweet gourd ketchup. It was also observed that the number total viable bacteria were greater than the mould.

Table 11. Total count of mould and yeast log (cfu/ml) after 2 months

Sample No.	No. of colony		Dil^n No.	No. of total		Total (logcfu/ml)	
	Mould	Yeast		Mould	Yeast	Mould	Yeast
S_1	4		1	4x10	-	1.60	-
S_2	7	-	1	7x10	-	1.84	-
S_3	8	-	1	8x 10	-	1.90	-
S_4	9	-	1	9XI0	-	1.95	-
S_5	8	-	1	8x10	-	1.90	-
S_6	9	-	1	9X10	-	1.95	-
S_7	9	-	1	9X10	-	1.95	-

3.7 Sensory evaluation of sweet gourd ketchup

The sweet gourd ketchup was prepared by using different levels of thickening agents. The effect of thickening agent on the color, flavor, texture and overall acceptability were evaluated by a panel of 15 taste testing judges. The judges were independently examined the contents from each of the samples and assigned scores for the characteristics of color, flavor, texture and overall acceptability. The score was tabulated and analyzed for any variance among the formulations.

A two way analysis of variance ANOVA was carried out and the results revealed that there was a significant ($P < 0.01$) difference in color acceptability since the calculated F value (8.1683) was, greater than tabulated value (3.06). This indicated that the color of the sweet gourd ketchup were not equally acceptable. As shown in DMRT test revealed that the sample S_5 scored significantly better for color than the other sample. It was also shown that the sample S_1, S_2 and S_3 were not significantly different. The sample S_7 had the least color acceptability when compared with others. In case of flavor preference among the products of sweet gourd ketchup a two way ANOVA showed that the samples were significantly ($P<0.01$) affected by flavor acceptability. Since the calculated F value (8.4432) was greater than the tabulated value (3.06). The flavor of sample S_1 and S_5 were most preferred and sample S_4 was less preferred for flavor. It was also noticed that there was no statistically significant difference among the sample of S_1 and S_5. It was also shown that the sample S_2, S_3 and S_7 were equally acceptable.

Significant texture difference ($P<0.01$) were revealed among the sample of sweet gourd ketchup as calculated F value (11.9371) was greater than tabulated (3.06) value. It was indicated that the samples S_4 and S_5 are equally acceptable. It was also shown that the sample S_2 and S_6 are equally acceptable and sample S_1 less acceptable than other samples.

Table 12. Mean scores of sensory evaluation for sweet gourd ketchup

Samples	Sensory attributes			
	Colour	Flavour	Texture	Overall acceptability
S_1	7.733^{ab}	7.867^{a}	5.933^{e}	6.933^{bc}
S_2	7.200^{bc}	6.600^{bc}	6.867^{bcd}	7.667^{ab}
S_3	7.267^{abc}	6.400^{bc}	6.200^{de}	6.133^{d}
S_4	6.933^{bcd}	6.133^{c}	7.667^{ab}	6.000^{d}
S_5	8.067^{a}	7.733^{a}	7.867^{a}	7.933^{a},
S_6	6.733^{cd}	7.200^{ab}	7.267^{abc}	7.267^{ab}
S_7	6.3333^{d}	6.800^{bc}	6.467^{cde}	6.467^{cd}
LSD	0.7675	0.8494	0.7965	0.7272

Sample S_1 - Control sweet gourd ketchup
Sample S_2 - Ketchup prepared with 1% starch
Sample S_3 - Ketchup prepared with 2% starch
Sample S_4 - Ketchup prepared with 3% starch
Sample S_5 - Ketchup prepared with 0.3% CMC
Sample S_6 - Ketchup prepared with 0.5% CMC
Sample S_7 - Ketchup prepared with 0.7% CMC

It was apparent from the results of the ANOVA that there was significant (13<0.01) difference in overall acceptability among the products of sweet gourd ketchup. Since the calculated value F (14.78) was greater than the tabulated value (3.06). This indicated that the overall acceptability of the sweet gourd ketchup is not equally acceptable. The sample S_5 the best and the samples S_3 and S_4 had the least overall acceptability as compared to the other samples. It was also shown that the sample S_2 and S_6 were not of significantly different and the samples S_1 and S_7 are equally acceptable by the judges.

Samples S_5 had better overall acceptability and better than other experimental samples. It may be mentioned there S_5 was treated with 0.3% CMC, where S_6 was treated with 0.5% CMC. It also indicated that neither the starch nor the higher level of CMC is suitable for production of highly acceptable sweet gourd ketchup.

SUMMARY AND CONCLUSION

This study reports on preparation of sweet gourd ketchup by incorporating different levels of thickening agents (starch & CMC) with sweet gourd pulp on pulp weight basis and analyzed for their various physical, chemical and microbial properties. The pulp prepared from fresh sweet gourd was the base for the formulation of different types of sweet gourd ketchup (S_1, S_2, S_3, S_4, S_5, S_6 & S_7).In addition to sweet gourd pulp, the other ingredients of the ketchup were either starch or CMC, sugar, salt and various spices. The analysis of the sweet gourd pulp showed that the pulp contained Moisture content, ash, protein, dry mater, sugar and mg/100gm vit C.

In this study it was observed that the TSS of the Sweet gourd ketchup 25% which is similar to TSS of tomato ketchup. The other main functional parameter of tomato and sweet gourd ketchup was less difference. So sweet gourd pulp may processed as a ketchup as like as tomato ketchup.

The moisture content (on the day of preparation) of sweet gourd ketchup prepared without thickening agent (control), 1% starch, 2% starch and 3% starch were 75.10%, 74.40%, 73.6% and 72.60%.The value of moisture content was decreased by the addition of higher percentage of starch rather than control. In case of CMC the lowest moisture content was 72.7% (on the day of preparation) for the sample of 0.7% CMC thickened and the highest moisture content was 75.1% for the control ketchup. It also shows that the moisture content is decreased with the increasing of CMC. The moisture content was significantly lower with CMC than ketchup with starch as thickening agent. The ash content of sweet gourd ketchup decreased gradually for application of both higher percentage of starch and CMC. Highest value of ash content was found in control ketchup (1.45%) and lowest was found 0.7% CMC thickened ketchup (1.28 %). The acidity of sweet gourd ketchup was gradually decreased for the application of both higher percentage of starch and CMC. Titrable acidity was highest in control sweet gourd ketchup and lowest in 0.7%

CMC treated sweet gourd ketchup. It was found that vitamin C (ascorbic acid) was reduced in sweet gourd ketchup for the addition of starch and CMC rather than control. Ascorbic acid was also lost during storage due to high sensitivity of thickening agent with time and temperature. It was found that TSS content increased gradually for the addition of both starch and CMC. On the other hand the highest TSS content was found in sample S_4 (3% Starch) and lowest in sample S_1 (Control Ketchup). Also during the storage period (0 day to 6 Month) in all cases (control, starch and CMC), the TSS content not changed remarkably.

It was also found that the thickening agent seriously influence the weight of sweet gourd ketchup. The weight of sweet gourd ketchup was increased with the increase of thickening agent. 0.7% CMC gave the highest weight of 1470 gm in all samples.

The result of the microbiological study shows that the bacterial count decreased with the increasing of thickening agent. The lowest score was Observed in sample S_7 (0.7%CMC) and highest in sample S_1 (Control). Viable bacterial count increased also with the increase of storage period. It also found that there was no countable yeast present in sweet gourd ketchup. The maximum mould was found in sample S_4 and less amount of mould was found in sample S_1 (Control).It also observed that the number of total viable bacteria was greater than the mould.

Various level of starch (1 to 3%) and CMC (0.3% to 0.7%) addition in the sweet gourd formulation and storage period noticeably influenced the reducing sugar of the sweet gourd ketchup. reducing sugar of sweet gourd ketchup in all sample condition (control, starch and CMC) were highest after 6 month storage. also the value of reducing sugar lowest at Control Sample than other sample. A Statistical analysis on the response of taste panel on the sensory properties of sweet gourd ketchup revealed that the colour, flavour, texture and overall acceptability of different sweet gourd ketchup were significantly ($p<0.001$) affected. The colour and flavour of the sweet gourd ketchup sample S_5 was significantly better than that of the other ketchup sample accept control sample. The flavour acceptability of control sample (S_1) and sample S_5 were better while ketchup sample S_4 had least flavour acceptability. The texture preference of ketchup sample S_5 was significantly better than the other ketchup samples. The overall acceptability of the ketchup sample S_5 had the best overall acceptability as compared to the other samples.

This study has demonstrated that incorporation of different level of starch and CMC to the sweet gourd ketchup formulation has improved the ketchup quality attribute especially flavour, texture, weight and volume. However CMC was found more suitable than the starch. On the basis of organoleptic evaluation of the sweet gourd ketchup it may be conclude that good quality sweet gourd ketchup sample S_5 may be processed by incorporating 0.3% CMC in formulation of sweet gourd ketchup for nutritional value and potential commercial production.

Higher income and more active life style in the country in recent years have resulted in consumers seeking high quality conventional food items in the market. The formulated sweet gourd ketchup, for its wide spared use, may thus help fill needs of consumer for quality sweet gourd ketchup. From the study it may be concluded that sweet gourd can be successfully and economically preserved by ketchup preparation. Further studies may include detailed analysis of nutritional constituents and functional properties of sweet gourd ketchup in order to assess the quality standard of the finished products.

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