

# Optimisation of Ready to Eat Paneer with Different Levels of Fructooligosaccharides, Sugar and Orange Juice Based on Sensory Characteristics

**ASIF ALI T S<sup>1</sup>, VENKATESH M<sup>2</sup>, ARUN KUMAR H<sup>3</sup>, PRAVEEN A R<sup>4</sup>,  
RAMACHANDRA B<sup>5</sup>, PUSHPA B P<sup>6</sup>**

M.Tech. Scholar, Dept. of Dairy Technology, Dairy Science College, Bangalore, India.<sup>1</sup>

Professor, Dept. of Dairy Technology, Dairy Science College, Bangalore, India.<sup>2</sup>

Professor and Head, Dept. of Dairy Technology, Dairy Science College, Bangalore, India.<sup>3</sup>

Associate Professor, Dept. of Dairy Technology, Dairy Science College, Bangalore, India.<sup>4</sup>

Associate Professor and Head, Dept. of Dairy Microbiology, Dairy Science College, Bangalore, India.<sup>5</sup>

Assistant Professor, Dept. of Dairy Chemistry, Dairy Science College, Bangalore, India.<sup>6</sup>

**Abstract:** The current study was carried out to investigate the improved utilisation of ingredients in the formulation of ready-to-eat paneer. During the optimising procedure, several concentrations of ingredients were optimised using sensory analysis. Sensory factors like colour and appearance, body and texture, flavour and overall acceptability were assessed. For the optimisation of the final ready-to-eat paneer, the best-judged level of ingredients was used. Ready to eat paneer was optimised with the sensory score of different levels of FOS, sugar and orange juice. Among the different levels of ingredients, the developed ready to eat paneer was optimised with 5 per cent FOS, 40 per cent sugar and 15 per cent orange juice.

**Keywords:** Paneer, FOS, sugar, orange juice, sensory analysis

## I. INTRODUCTION

Paneer is a popular heat and acid coagulated indigenous dairy product that is used as a basis for a variety of culinary dishes. In India, 5 per cent of the total milk produced is used to make paneer and channa. A CAGR of 15–18 per cent is anticipated for the Indian paneer market between 2020 and 20225 (Raja, 2021).

Paneer is mostly used as a culinary dish material. Mostly usage of paneer was restricted inside the house hold and restaurant kitchens. But paneer can also be used as a ready to eat food product and can be consumed without any further processing. Huge opportunity is available in the field for development of ready to eat paneer. The main advantage of this ready to eat paneer, it increases the functional property and also it increases the keeping quality of the paneer.

Sugar which is also called sucrose is extracted from sugarcane or sugar beet. Sucrose is a disaccharide composed of glucose and fructose. Sugar is useful in food processing and is frequently used to improve flavour, but it can also be used to improve food texture, add bulk, extend the shelf life of packaged foods and make goods moist. The amount of total solids in dairy products rises due to addition of sugar.

Fructooligosaccharides (FOS) are good source of dietary fiber or a group of nutrients or non-digestible short chain carbohydrates which human body cannot digest and it stimulates the growth and activity of some friendly bacteria in your intestinal tract. Prebiotics fibres are linked to  $\beta$ -(2→1) fructosyl units and are universally agreed to be FOS or oligofructose or oligosaccharide or inulin. FOS enhance the sensory qualities and texture of dairy products, as well as bowel function and the risk of colorectal cancer.

Fruit juice is a major source of dietary vitamins and minerals, orange juice is rich in vitamin C. Oranges are also a good source of fibre, B complex vitamins, vitamin A, calcium and potassium. However, oranges contain a range of other plant compounds and antioxidants that may reduce inflammation and work against disease. The orange gives the pleasant fruity and more acceptable flavour to the product which is incorporated with it. It gives a sweet to sour orangey flavour.

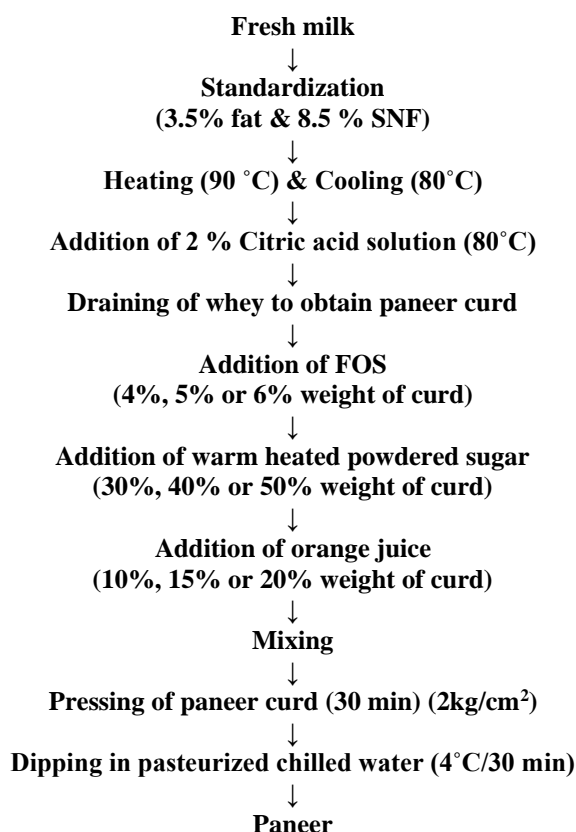
## II. MATERIALS AND METHODS

### Materials

Fresh Cow milk was procured from Students Experimental Dairy Plant (SEDP) of Dairy Science College, Hebbal, Bengaluru. Citric acid used for coagulation of milk was manufactured by Prince Chemical Co., Bengaluru, Karnataka. Fructooligosaccharide liquid was procured from Foslife manufactured by Revelation biotech, Hyderabad. The sugar used was manufactured by Madhur fine grain sugar produced by Shree Renuka sugars ltd, Mumbai, Maharashtra. The orange juice of 35 per cent orange pulp is procured from Mala's fruits crush, Panchgani, Maharashtra.

### Preparation of ready to eat paneer

The standardised milk is heated to 90°C/hold and cooled to 80°C. With moderate stirring, the coagulating agent citric acid is introduced to milk in a 2 per cent solution at 80°C. The added milk was left undisturbed for 2 minutes. After that, a muslin cloth is used to separate the clear whey. FOS, warm heated powdered sugar and orange juice are combined well into the paneer curd. The temperature of the coagulum should be maintained during the addition of ingredients. Lower temperature of addition of ingredients will affect the paneers body and texture. Then coagulum pressed for 30 minutes (2 kg/cm<sup>2</sup>). It is then submerged for 30 minutes in pasteurised cold water (4°C).



### Sensory Analysis (9-Point Hedonic Scale)

Paneer produced with various quantities of FOS, sugar, and orange juice was sensory tested against control paneer. A panel of five trained judges was assembled, and factors such as colour and appearance, body and texture, flavour and overall acceptability were scrutinised. Based on the sensory results, an optimal formulation with suitable levels of FOS, sugar, and orange juice was chosen.

**Statistical Analysis**

The data was analysed using IBM SPSS statistics software for statistical computing. Data on the response variables were collected for three replications for each of the treatments. ANOVA tables were prepared to analyse the data and where the F value was significant, the critical difference was calculated (P=0.05) and used to identify whether significant differences existed and indicated in the table using superscripts.

**III. RESULT AND DISCUSSION**

**Effect of Fructooligosaccharides on the Sensory Attributes of Paneer**

The level of FOS with the paneer had to be selected for incorporation. FOS was added at 3 levels i.e., 4per cent, 5 per cent and 6 per cent to the weight of coagulum. The paneer samples were subjected for sensory analysis against the control sample and the results were statistically analysed.

**Table 1: Effect of fructooligosaccharides on the sensory attributes of paneer**

Sample	Colour & Appearance	Body & Texture	Flavour	Overall Acceptability
CP	8.33 <sup>a</sup>	8.33 <sup>a</sup>	8.17 <sup>a</sup>	8.33 <sup>a</sup>
F1	7.97 <sup>a</sup>	8.33 <sup>a</sup>	7.17 <sup>b</sup>	7.67 <sup>b</sup>
F2	8.00 <sup>a</sup>	8.50 <sup>ab</sup>	7.67 <sup>ab</sup>	8.17 <sup>a</sup>
F3	8.15 <sup>a</sup>	8.87 <sup>b</sup>	7.00 <sup>b</sup>	7.47 <sup>b</sup>
<b>CD (P=0.05)</b>	<b>NS</b>	<b>0.48</b>	<b>0.62</b>	<b>0.50</b>

CP - Control paneer, F1 - Paneer with 4% FOS, F2 - Paneer with 5% FOS, F3 - Paneer with 6% FOS, CD - Critical difference, NS - Non – significance, All the values are average of three trials, Similar superscripts indicate non - significance at the corresponding critical difference

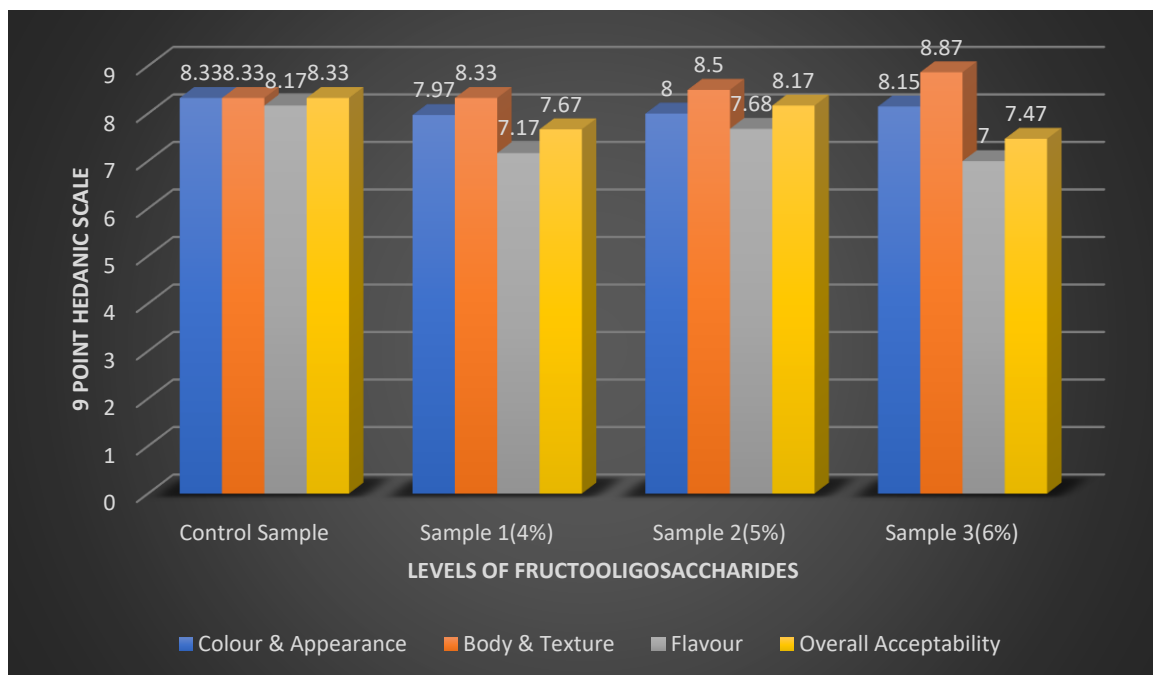


Fig 1: Effect of fructooligosaccharides on the sensory attributes of paneer

Significant difference (P>0.05) was not observed between colour and appearance score of control and other treated samples. In comparison to the other samples in the experiment, the experimental paneer sample treated with 5 per cent

FOS received the highest colour and appearance score of 8.00 other than control, while the experimental paneer sample added with 4 per cent FOS received the lowest score of 7.97. There results were similar were decrease in colour score was also noticed by Kavas *et al.* (2021) in the study related to effect of using microencapsulated pro and prebiotics on the aromatic compounds and sensorial properties of synbiotic goat cheese, were cheese prepared with 2 per cent of FOS received less score than that of control sample.

The addition of FOS has significant ( $P < 0.05$ ) impart in the body and texture of paneer. 6 per cent FOS paneer sample had score of 8.87 which is more than all samples and sample with 4 per cent FOS and control secured the least score of 8.33 of all four samples. An increase in body and texture score can be seen with increase in per cent of FOS. The result goes parallel with study of Desai *et al.* (2017) on texture profile and sensory characteristics of low fat sweetened ready to eat (SRTE) paneer cubes prepared with optimum levels of hydrocolloids, were it revealed that paneer prepared with 0.75 per cent of FOS had better body and texture score than control paneer.

The score of flavour was highest for control sample of 8.17 than experimental samples and least score of 7.00 for experimental sample with 6 percent FOS. There is significant ( $P < 0.05$ ) difference on all samples. Adding FOS to paneer after coagulation would likely not have a significant effect on the flavour or sensory characteristics of paneer. The results slightly differ from the finding of Buran *et al.* (2021) were he conducted study on rheological, sensorial and volatile profiles of synbiotic kefir produced from cow and goat milk containing varied probiotics in combination with FOS. That study showed that kefir prepared with 2 per cent FOS showed slightly higher score than control sample without FOS.

The overall acceptability score of experimental paneers added with various levels of FOS and control paneer showed a statistically significant difference ( $P < 0.05$ ). Experimental paneer with 5 per cent FOS was optimized as it secured the highest overall acceptability score of 8.17. The result goes in line with the study of Barbosa *et al.* (2016) were he prepared creamy goat cheese with addition of 8 per cent of FOS like dietary fiber has better overall acceptability.

**Effect of Sugar on The Sensory Attributes of Paneer**

Based on the results of the preliminary trials conducted FOS of level 5% to the weight coagulum was optimised to these different levels of sugar 30 per cent, 40 per cent or 50 per cent was added. Sensory analysis was done and the data was statistically interpreted.

**Table 2: Effect of sugar on the sensory attributes of paneer**

Sample	Colour & Appearance	Body & Texture	Flavour	Overall Acceptability
CP	8.33 <sup>a</sup>	8.33 <sup>a</sup>	8.17 <sup>a</sup>	8.33 <sup>a</sup>
S1	8.17 <sup>a</sup>	7.95 <sup>ab</sup>	7.92 <sup>ab</sup>	7.93 <sup>ab</sup>
S2	8.10 <sup>a</sup>	7.78 <sup>b</sup>	8.00 <sup>a</sup>	8.00 <sup>ab</sup>
S3	8.00 <sup>a</sup>	7.50 <sup>b</sup>	7.67 <sup>b</sup>	7.70 <sup>b</sup>
<b>CD (P=0.05)</b>	<b>NS</b>	<b>0.52</b>	<b>0.39</b>	<b>0.33</b>

CP - Control paneer, S1 - Paneer with 5% FOS and 30% sugar, S2 - Paneer with 5% FOS and 40% sugar, S3 - Paneer with 5% FOS and 50% sugar, CD - Critical difference, NS - Non – significance, All the values are average of three trials, Similar superscripts indicate non - significance at the corresponding critical difference

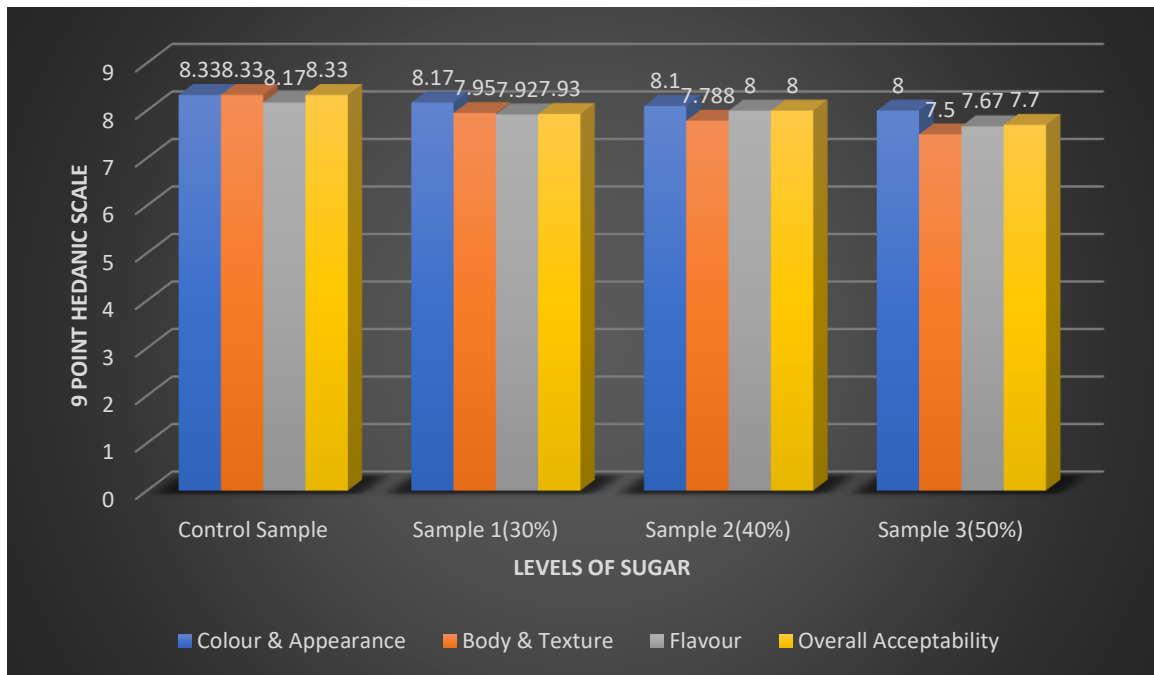


Fig 2: Effect of sugar on the sensory attributes of paneer

Different levels of sugar had no significant ( $P > 0.05$ ) effect on the colour and appearance of experimental paneer. The highest score of 8.33 was awarded to the paneer with 40 percent sugar which is greater than control and rest of experimental samples. The lowest value of 8.00 was for paneer sample with 50 percent sugar. The result obtained differs with the work of Gotarne *et al.* (2015) where he optimized different levels of date powder and sugar in brown dates-peda. In his work the colour and appearance score of peda increased from sugar level of 13 per cent to 27 per cent.

The score for body and texture of the control sample was 8.33 which is higher among all samples. The addition of sugar reduced the body and texture score. The lowest score of 7.50 goes to 50 per cent sugar sample. The samples show significant ( $P < 0.05$ ) difference with addition of sugar. The findings of this work agree with the study of Ahmad and David (2017) where they prepared diabetic rasgulla with aspartame replacing sugar. The body and texture were less appealing for control sample with 40 per cent sugar than other samples prepared with aspartame.

The obtained sensory score for flavour of the control sample was 8.17 and 40 per cent sugar added sample was 8.00 which is highest among experimental samples. A minimum score of 7.67 was for 50 per cent sugar added sample. Various levels of sugar had significant ( $P < 0.05$ ) influence on the flavour of experimental paneer. Observation of this study goes hand in hand with observation of Daillant and Issanchou (1993) in the influence of sugar and fat contents on preference for cream cheese. He showed that the effect of sugar was significant overall, however, 8 g per 100 g (medium level) seemed to be the closest to ideal.

The score for overall acceptability of the control sample was 8.33 and experimental paneer with 40 per cent sugar was 8.17 and other two experimental samples received less score than this. Statistical analysis showed that different levels of sugar had significant ( $P < 0.05$ ) effect on the overall acceptability of experimental paneer. Experimental paneer with 40 per cent sugar was optimized as it secured the highest overall acceptability score of 8.17. The result disagrees with Gotarne *et al.* (2015) where he optimized different levels of date powder and sugar in brown dates-peda, there the overall of peda increased from sugar level of 13 per cent to 27 per cent.

### Effect of Orange Juice on The Sensory Attributes of Paneer

Based on the results of the preliminary trials conducted paneer with FOS of level 5 per cent and sugar of 40 per cent to the weight coagulum was optimized to these different levels of orange juice of 10 per cent, 15 per cent or 20 per cent was added. Sensory analysis was done and the data was statistically analysed.

Table 3: Effect of orange juice on the sensory attributes of paneer

Sample	Colour & Appearance	Body & Texture	Flavour	Overall Acceptability
CP	8.33 <sup>a</sup>	8.33 <sup>a</sup>	8.17 <sup>a</sup>	8.33 <sup>a</sup>
O1	8.15 <sup>a</sup>	8.13 <sup>ab</sup>	8.42 <sup>ab</sup>	7.92 <sup>b</sup>
O2	8.00 <sup>a</sup>	8.17 <sup>a</sup>	8.59 <sup>ab</sup>	8.33 <sup>a</sup>
O3	7.80 <sup>a</sup>	7.75 <sup>b</sup>	8.75 <sup>b</sup>	7.95 <sup>b</sup>
<b>CD (P=0.05)</b>	<b>NS</b>	<b>0.41</b>	<b>0.42</b>	<b>0.32</b>

CP - Control paneer, O1 - Paneer with 5% FOS, 40% sugar and 10% orange juice, O2 - Paneer with 5% FOS, 40% sugar and 15% orange juice, O3 - Paneer with 5% FOS, 40% sugar and 20% orange juice, CD - Critical difference, NS - Non – significance, All the values are average of three trials, Similar superscripts indicate non - significance at the corresponding critical difference

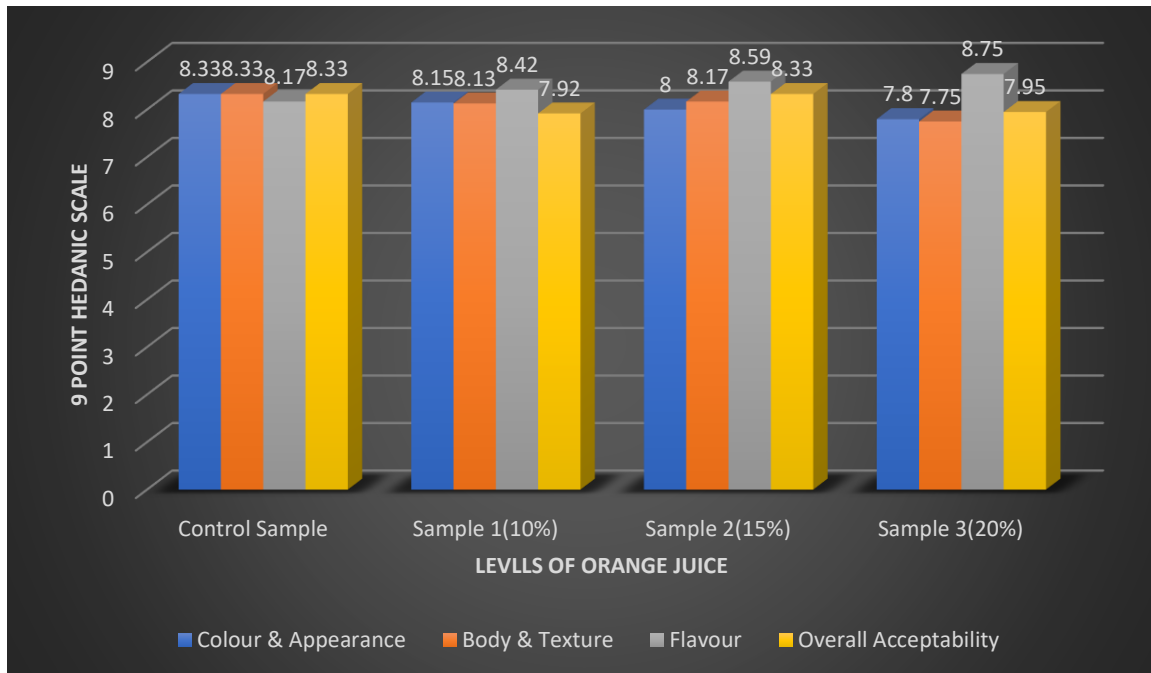


Fig 3: Effect of orange juice on the sensory attributes of paneer

The value of 8.33 for colour and appearance was highest and it was for control sample. A decrease in score can be found out with increase in percentage of orange juice. Varying the levels of orange juice had no significant ( $P>0.05$ ) effect on the colour and appearance of experimental paneer. Beta-carotene other carotenoids present in oranges, such as lutein and zeaxanthin are the pigments imparting orange colour to the panner. The dissimilar patten of increase of score of colour and appearance with increase in orange juice was also showed by Kumar *et al.* (2019) in his work of developing evaporated milk shrikhand and vitamin C enrichment by using malta orange juice were, the score increases from 0 per cent to 16 per cent of orange juice.

The observed score for body and texture of the control sample was 8.33 and remaining samples have less score than control with least score of 7.75 for experimental paneer with 20 per cent orange juice. Statistical analysis revealed that different levels of orange juice had significant ( $P<0.05$ ) impact on the body and texture of experimental paneer. The result is similar with the study of Ahmed and Bajwa (2022) effect of fruit acidulants on instrumental colour values and sensory qualities of paneer, were paneer prepared with lemon has less body and texture score than control.

The obtained sensory score for flavour was highest (8.75) for experimental sample with 20 per cent. Increase in orange juice proportionally increase the sensory score of flavour thus the least score of 8.17 was attained by control sample. Different levels of orange juice had significant ( $P < 0.05$ ) influence on the flavour of experimental paneer. Limonene which is a terpene is responsible for the characteristic citrus aroma of oranges. Adding orange juice to paneer after coagulation may impart a citrusy flavour to the paneer. The study on physicochemical and sensory characteristics of orange juice supplemented yogurt by Yasmin *et al.* (2022) also says the same findings that the flavour of orange (3 per cent) added yogurt significantly higher than that of control yogurt.

The marks for overall acceptability are in the order the control sample with 8.33, followed by 15 percent sample (8.13), 20 percent sample (7.95) and 10 per cent (7.92). Statistically different levels of orange juice had significant ( $P < 0.05$ ) effect on the overall acceptability of experimental paneer. The result obtained is similar with the work of El-Dardiry *et al.*, (2017) were effect of using orange on the physico-chemical properties of ricotta cheese. In that study the overall acceptability of whey ricotta cheese increases with increase in orange (0 to 3 per cent) then decreases after certain limit (5 per cent).

#### IV. CONCLUSION

Addition of different percentages of FOS (4, 5 and 6 per cent) in paneer resulted in paneer with 5 per cent FOS having higher sensory scores. It received 8.00, 8.00, 7.67 and 8.17 out of 9.00 for colour and appearance, body and texture, flavour and overall acceptability, compared to 8.17, 7.83, 7.83 and 7.83 for the control sample respectively.

Among the different sugar levels (30, 40 and 50 per cent), paneer with 40 per cent sugar achieved higher and comparable sensory scores to control in terms of colour and appearance, body and texture, flavour and overall acceptability of 8.50, 8.08, 8.00 and 8.17 out of 9.00, respectively, compared to 8.33, 8.33, 8.00 and 8.17 for the control sample. The inclusion of various levels of orange juice (10, 15 and 20 per cent) to paneer, paneer with 15 per cent orange juice achieved sensory scores that were comparable to the control sample in terms of colour and appearance, body and texture, flavour and overall acceptability of 8.33, 8.17, 8.59 and 8.17 out of 9.00, compared to 8.33, 8.33, 8.17 and 8.33 for the control sample.

#### V. ACKNOWLEDGEMENT

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