iJRASET
International Journal For Research in
Applied Science and Engineering Technology

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY

Volume: 14 **Issue:** IV **Month of publication:** April 2026

DOI: https://doi.org/10.22214/ijraset.2026.80398

International Journal for Research in Applied Science & Engineering Technology (IJRASET)
ISSN: 2321-9653; IC Value: 45.98; SJ Impact Factor: 7.538
Volume 14 Issue IV Apr 2026- Available at www.ijraset.com

Formulation of a Functional Low-Calorie Sweet and Sour Gherkin Chips Pickle with Non-Nutritive Sweeteners

Gooty Mohammed Asif[1*], Dr. A. Swaroopa Rani[1], M. Sairam[2]
[1*]*Student, Department of Food Technology, Oil Technological & Pharmaceutical Research Institute, J.N.T University, Ananthapuramu-515001, Andhra Pradesh, India.*
[1]*Professor, Department of Food Technology, Oil Technological & Pharmaceutical Research Institute, J.N.T University, Ananthapuramu-515001, Andhra Pradesh, India.*
[2]*Quality and Food Safety Manager, Global Green Company Limited, Obulapura Village, Anugondanahalli Post, Hoskota Taluk, Bangalore-560117, Karnataka, India.*

Abstract: The increasing demand for low-calorie and health-oriented has led to the development of innovative formulations in traditional pickles. This study focuses on the formulation of a functional low-calorie sweet and sour gherkin chips pickle with non-nutritive sweeteners as a substitute for conventional sugar. Gherkins (Cucumis sativus) were processed into chips and subjected to different formulation trials by varying the type and concentration of sweeteners. The prepared samples were analysed for physicochemical properties, including titratable acidity, salt content, total soluble solids (TSS), and pH, along with sensory attributes such as taste, texture, odour, appearance, and overall acceptability. Among the different trials, the optimized formulation exhibited a desirable balance of sweetness and sourness with improved sensory scores, while significantly reducing caloric content. The use of non-nutritive sweeteners not only enhanced the suitability of the product for health-conscious consumers but also maintained the traditional flavor profile of pickles. Microbial stability and shelf-life aspects were also considered to ensure product safety and quality. This research study has successfully developed low-calorie pickle by using non-nutritive sweeteners in pickle formulations to produce healthier alternatives without affecting product quality and shelf-life stability.

Keywords: Gherkin (Cucumis Sativus) Chips, Low-Calorie Pickle, Non-Nutritive Sweeteners, Physicochemical Properties, Sensory Evaluation, Shelf-Life Stability.

I. INTRODUCTION

Food preservation is an essential technique used to extend the shelf life of food by preventing microbial growth, enzymatic activity, and chemical deterioration. Among various preservation methods, pickling is one of the oldest and most widely practiced techniques, particularly for fruits and vegetables. Pickling involves the use of acidic solutions, commonly vinegar (acetic acid), along with salt and spices to create an environment that inhibits the growth of spoilage-causing microorganisms. The reduction in pH and increase in osmotic pressure help in preserving the food while also enhancing its flavor, texture, and overall acceptability. This method is especially popular in traditional food systems due to its simplicity, cost-effectiveness, and ability to produce unique sensory characteristics (Fellows, 2009; Rahman, 2007). Pickling can be broadly classified into fermented pickling and non-fermented pickling. The non-fermented pickling involves direct addition of acids like vinegar to achieve preservation. This technique not only increases the shelf life but also contributes to the development of desirable taste and aroma. (Jay et al., 2005; Potter & Hotchkiss, 1995).

Gherkin (Cucumis sativus L.) is a small variety of cucumber widely cultivated for pickling purposes due to its firm texture, uniform size, and ability to retain crispness after processing. It is commonly grown in tropical and subtropical regions and has gained significant commercial importance in the food processing industry, particularly in the production of pickles. Gherkins are rich in moisture, dietary fiber, and essential nutrients, making them suitable for developing value-added food products. Their mild flavor and adaptability to different preservation techniques, especially pickling in brine or vinegar, make them an ideal raw material for both traditional and industrial applications.

In recent years, gherkins have also been explored for the development of low-calorie and functional food products due to increasing consumer demand for healthier alternatives (Robinson, R.W., Srinivasa Rao et al., 2012; USDA, 2020). Vinegar plays a crucial role in pickle preservation by providing an acidic environment that inhibits the growth of spoilage and pathogenic microorganisms. It primarily contains acetic acid, which lowers the pH of the product, thereby enhancing microbial stability and extending shelf life. Calcium chloride is commonly used in pickle processing as a firming agent to maintain the crispness and texture of gherkins during storage. It works by strengthening the cell wall structure through the formation of calcium pectate, which prevents softening caused by enzymatic degradation (Fellows, 2009; Rahman, 2007). Salt is one of the most important ingredients in pickling due to its preservative and functional properties. It helps in reducing water activity by drawing out moisture from the gherkin tissues through osmotic pressure, thereby inhibiting microbial growth. (Jay et al., 2005; Potter & Hotchkiss, 1995)

Stevia is a natural non-nutritive sweetener derived from the leaves of Stevia rebaudiana, widely used as a sugar substitute in low-calorie food products. It contains steviol glycosides, which provide intense sweetness without contributing calories, making it suitable for diabetic and weight-conscious consumers. Erythritol is a sugar alcohol commonly used as a low-calorie sweetener in food applications. It provides approximately 70% of the sweetness of sucrose but with negligible caloric contribution and minimal impact on blood glucose levels (Grembecka, 2015; Livesey, 2003).

The growing awareness of health and nutrition has led to increased demand for low-calorie and functional food products, particularly among individuals managing obesity, diabetes, and other lifestyle-related disorders. Traditional pickles, although popular for their taste and preservative qualities, often contain high amounts of sugar and salt, contributing to increased caloric intake. Gherkin (Cucumis sativus L.), due to its firm texture, mild flavor, and suitability for pickling, serves as an ideal raw material for such innovations. The incorporation of non-nutritive sweeteners such as Stevia and Erythritol allows for the reduction of sugar content without compromising sweetness, making the product suitable for health-conscious consumers (Fellows, 2009; Grembecka, 2015). The preparation of sweet and sour gherkin chips pickle involves slicing fresh gherkins into uniform chips followed by preservation in an acidic medium, typically vinegar, along with salt, spices, and sweetening agents. The balance between acidity, sweetness, and salt concentration plays a critical role in determining the sensory acceptability and shelf stability of the product. Physicochemical parameters such as pH, titratable acidity, total soluble solids (TSS), and salt content are important indicators of product quality, while sensory evaluation helps in identifying the most acceptable formulation (Rahman, 2007; Jay et al., 2005).

Furthermore, ensuring microbial safety and shelf-life stability is essential in pickle production. The acidic environment, combined with proper salt concentration and hygienic processing conditions, inhibits the growth of spoilage and pathogenic microorganisms. The development of low-calorie gherkin pickle thus represents a promising approach to producing healthier value-added products without compromising traditional sensory attributes. This study focuses on optimizing formulation and evaluating the quality characteristics of low-calorie sweet and sour gherkin chips pickle (Potter & Hotchkiss, 1995; Srinivasa Rao et al., 2012).

II. MATERIALS AND METHODS

A. Materials

Fresh Gherkin chips, Vinegar, Salt, Calcium chloride, Stevia, Erythritol, Water, Yellow mustard, Celery seeds, sweet cucumber oleoresin, Celery spice extract flavor, these are the raw materials used in the preparation of low-calorie gherkin chips pickle as shown in fig-1.

Fig. 1. raw materials for low-calorie gherkin chips pickle

B. Methods

1) Process of low-calorie gherkin chips pickle

Fresh gherkins were first selected along with other ingredients such as vinegar, salt, spices, calcium chloride ($CaCl_2$), stevia, and erythritol (Kumar & Joshi, 2017). The selected gherkins were then sorted and graded to remove damaged or over-matured samples (Lal et al.,2018). After sorting, the gherkins were washed and cut into uniform slices. A cover medium (brine solution) was prepared using vinegar, salt, stevia, erythritol, calcium chloride, and required flavouring agents (Desrosier & Desrosier, 1977). Clean glass jars were washed thoroughly, the sliced gherkin chips were then filled into the washed jars, followed by the addition of measured spices (approximately 1 g). The prepared cover medium was added to the jars to completely immerse the gherkin slices. Air bubbles were removed by gentle tapping, and the jars were then capped properly.

The capped jars were subjected to pasteurization at 75–80°C for 30 minutes to ensure microbial safety (Jay et al., 2005). After pasteurization, the samples were incubated for 5–7 days to allow proper flavor development (Battcock & Azam-Ali, 1998). Subsequently, physio-chemical analyses including pH, total soluble solids (TSS), acidity, texture, and salt content were carried out (AOAC, 2019). Sensory evaluation was also performed based on parameters such as appearance, odour, taste, texture, mouthfeel, and overall acceptability (Meilgaard et al., 2007). Finally, a storage study was conducted at 37°C to evaluate the shelf stability of the developed product (Ranganna, 2010).

2) Composition of low-calorie gherkin pickle

The three variations are made to make the low-calorie gherkin chips pickle

Table-1 composition for different trails for gherkin pickle

Ingredients	**Control sample ml/gm**	**Trail -1 ml/gm**	**Trail-2 ml/gm**	**Trail-3 ml/gm**
Vinegar	130 ml	130	130	130
Salt	15 gm	15	15	15
Calcium chloride	6.2 gm	6.2	6.2	6.2
Stevia	-	0.80	1.10	1.40
Erythritol	-	200	280	340
Water	To make up to volume	To make up to volume	To make up to volume	To make up to volume
Yellow mustard	1 gm	1	1	1
Celery seeds	1	1	1	1
Sweet cucumber oleoresin	0.70 gm	-	0.70	0.70
Celery spice extract	0.05 gm	-	0.05	0.05

III. PHYSICO-CHEMICAL ANALYSIS

A. Vacuum Test

The vacuum test is performed to assess the sealing efficiency of the pickle container by measuring internal pressure using a vacuum gauge. Adequate vacuum indicates proper sealing and helps maintain product quality and safety. Low vacuum levels may lead to spoilage, microbial growth, and reduced shelf life (Robertson, G. L. (2016).

B. Cap Security

Cap security is evaluated using a torque tester to determine the force required to open or close the lid. Proper torque ensures effective sealing and prevents leakage or cap deformation. Poor cap security can result in spoilage and compromised product safety (Robertson, G. L. (2016).

C. Head Space
Headspace refers to the space between the product and the lid, typically maintained between 0.5 to 1.0 cm. Correct headspace ensures proper sealing, prevents overflow, and reduces contamination risk. Improper headspace may cause leakage, weak vacuum, or oxidation (Ranganna, 2010).

D. pH
pH is a key indicator of acidity that determines the safety and stability of pickle products. It was measured using a calibrated pH meter after homogenizing the sample with distilled water. Maintaining an appropriate pH (pH 4.0 and 7.0) is essential to inhibit microbial growth and ensure product quality (AOAC, 2019).

$$\mathrm{pH} = -\log\,[\mathrm{H}+]$$

E. Determination of Titratable Acidity (%)
Titratable acidity was determined by titrating the pickle sample with 0.1 N NaOH using phenolphthalein as an indicator until a persistent light pink endpoint was observed. The volume of NaOH consumed was recorded, and acidity was calculated and expressed as percentage of acetic acid (AOAC, 2019).

$$\text{Formula:} \quad \text{Titatable acidity } (\%)\, \frac{\mathrm{V \times N \times Eq.wt \times 100}}{\mathrm{W \times 1000}}$$

F. Determination of Salt Content
Salt content in the pickle sample was determined by Mohr's method, titrating 1 mL of sample against 0.1 N AgNO3 using potassium chromate as an indicator. The endpoint was marked by a color change from yellow to brick red, and the percentage of NaCl was calculated using the titration volume (AOAC, 2019).

$$\text{Formula:} \quad \mathrm{Salt(NaCl)\%} = \frac{\mathrm{V \times N \times Eq.wt\ of\ NaCl \times 100}}{\mathrm{W \times 1000}}$$

G. Determination of Total Soluble Solids (TSS)
Total soluble solids (TSS) were determined using a hand refractometer. A few drops of filtered pickle brine were placed on the clean prism, and the reading was taken against a light source. The TSS value was recorded in degrees Brix (°Brix). This value indicates the concentration of soluble solids present in the sample (AOAC, 2019).

IV. NUTRITIONAL ANALYSIS

A. Determination of Energy value
The energy value of the sample was estimated based on proximate composition, with protein determined by the Kjeldahl method, fat by Soxhlet extraction, and carbohydrates calculated by difference. Energy was computed using standard factors: 4 kcal/g for protein and carbohydrates, and 9 kcal/g for fat, as per FSSAI guidelines (AOAC, 2019., Ranganna, 2010).

$$\text{Formula:} \quad \text{Energy}\left(\frac{\text{kcal}}{\text{100g}}\right) = (\text{carbohydates} \times 4) + (\text{proteins} \times 4) + (\text{fats} \times 9)$$

B. Determination of Carbohydrates
In this method, Proximate composition of the food sample was determined using standard analytical methods, including estimation of moisture, protein, fat, ash, and crude fiber. The total carbohydrate content was calculated by difference, subtracting the sum of these components from 100 g of the sample (AOAC, 2019., Ranganna, 2010).

$$\text{Formula:} \quad \text{carbohydrates}(\%) = 100 - (\text{Moisture} + \text{protein} + \text{fat} + \text{ash} + \text{crude fiber})$$

C. Determination of Protein Content
Protein content was determined by the Kjeldahl method involving digestion of the sample with concentrated sulphuric acid and catalyst to obtain a clear solution. The liberated ammonia after alkalization was distilled, absorbed in boric acid, and titrated with 0.1 N HCl. The endpoint was indicated by a color change from green to pink (AOAC, 2019; Jay et al., 2005).

$$\text{Formula:} \quad \text{Nitrogen } (\%) = \frac{\mathrm{(V1-V2) \times N \times 14 \times 100}}{\mathrm{W \times 1000}}$$

V_1 = Volume of acid used for sample (ml), V_2 = Volume of acid used for blank (ml), N = Normality of acid, W = Weight of sample (g), 14 = Atomic weight of nitrogen.

D. Determination of fat Content

Fat content was determined by the Soxhlet extraction method using a non-polar solvent such as petroleum ether or hexane. The dried and ground sample was subjected to continuous extraction, followed by evaporation of the solvent. The extracted fat was dried and weighed, and the fat content was expressed as a percentage of the initial sample weight (AOAC, 2019; Fellows, 2009).

$$\text{Formula:} \quad \text{Fat content}(\%) = \frac{W_2 - W_1}{W} \times 100$$

W_1 = Weight of empty dry flask (g), W_2 = Weight of flask + extracted fat (g), W = Weight of sample taken (g)

V. RESULTS AND DISCUSSION

The Three trials (Trail-1, Trail-2, and Trail-3) were prepared using the same base formulation, with variations only in the type and proportion of non-nutritive sweeteners, which influenced sensory attributes. Visual observation showed slight differences in color clarity and uniformity of the gherkin slices, with Trail-3 exhibiting better transparency and more appealing appearance. Taste evaluation indicated that Trail-3 achieved a more balanced sweet and sour profile, with reduced bitterness and aftertaste compared to the other trials. The texture of the slices in Trail-3 was also found to be more acceptable, maintaining firmness without excessive softness. Based on overall sensory acceptability, Trail-3 was selected as the optimized formulation as shown in fig-2.

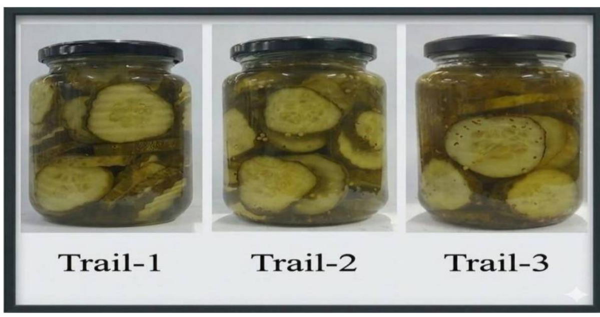


Fig-2: Pickle trails images

Fig-3 Pickle Final Product

A. Physio-Chemical Analysis

The results of physicochemical and packaging quality parameters analysis are shown in table-2. The both control and project samples were evaluated in accordance with standard FSSAI Manual and IS methods (FSSAI, 2016; BIS, 2012). The project sample showed slight improvement in vacuum and cap security, indicating better sealing efficiency, although both samples are meet the minimum vacuum specification (Fellows, 2009). Headspace values exceeded the prescribed limit in both cases, which may affect shelf stability. The acidity, salt content, °Brix, and pH of the project sample were within or very close to the recommended standards, indicating acceptable formulation and preservation conditions. Overall, the project sample demonstrated improved quality attributes compared to the control (Fellows, 2009; Rahman, 2007).

Table-2 Physico-Chemical Analysis results

Sl. No	Test parameters	Control sample results	Project sample results	Units	Specifications	Test methods
1	Vacuum	80	90	mmHg	Min 80-130	IS 9795: 1981 (RA 2020) FSSAI Manual
2	Cap security	5	6	inHg	3 to 7 mm	IS 9795: 1981 (RA 2020) FSSAI Manual
3	Head space	14	16	mm	Max 12	IS 13915: 1994 (RA 2019) FSSAI Manual
4	Acid	0.75	0.72	%	0.70 +/- 2	IS 1155: 1968 (RA 2010) FSSAI Manual
5	Salt	1.07	1.05	%	1.00 +/- 1	IS 5949: 1970 (RA 2020) FSSAI Manual
6	Brix	16.6	18.2	1º brix	16 – 18	IS 13815: 1993 (RA 2019) FSSAI Manual
7	pH	3.61	3.63	≤	≤4.10	IS 3025 (Part 11): 1983 (RA 2017) FSSAI Manual

B. Nutritional Analysis

The results of nutritional analysis are shown in table-3. The control and project samples revealed a significant reduction in energy value and carbohydrate content in the project formulation, indicating its suitability as a low-calorie product. Protein and fat contents remained unchanged between both samples, suggesting that the modification primarily affected carbohydrate levels without altering other macronutrients. The reduced caloric value in the project sample may be attributed to the use of non-nutritive sweeteners, enhancing its dietary benefits (Livesey, 2003). All analyses were conducted as per standard IS methods and FSSAI Manual guidelines (FSSAI, 2016; BIS, 2012)., ensuring reliability and accuracy of the results. Overall, the project sample demonstrates improved nutritional quality with potential applications in health-oriented food products.

Table-3 Nutritional Analysis results

SL.NO	Test parameters	Control sample	Project sample	Units	Test methods
1	Energy value	35	11	Kcal/100 gm	IS 13285: 1992 (RA 2022) FSSAI Manual
2	Carbohydrates	8.1	2.3	gm/100 gm	IS 1656: 2022 FSSAI Manual
3	Proteins	0.4	0.4	gm/100 gm	IS 7219: 1973 (RA 2020) FSSAI Manual
4	Total fats	0.07	0.07	gm/100 gm	IS 12711: 1989 (RA 2018) FSSAI Manual

C. Microbial Analysis

The Microbiological analysis results are shown in table-4. The total bacterial count was found to be 01 CFU/g (or ml), which is significantly lower than the permissible limit of less than 250 CFU/g, indicating good hygienic conditions during processing and handling (Jay et al., 2005). Similarly, the total yeast and mould count was not detected in the sample, remaining well within the acceptable limit of less than 100 CFU/g. These results suggest that the product is microbiologically stable and free from spoilage organisms (Frazier & Westhoff, 2004). The absence of yeast and mould growth further reflects effective preservation and proper storage conditions.

Table-4 Microbial analysis results

Sl. No	Microbiological parameters	Results	Specifications
1	Total bacterial count (CFU/g or ml)	01	<250
2	Total yeast & mould count (CFU/g or ml)	Nil	<100

D. Sensory Analysis

The Sensory evaluation results are shown in fig-3. It indicates that all formulations exhibited good acceptability across key attributes such as appearance, texture, taste, mouthfeel, odour, and overall acceptability (Stone & Sidel, 2004). Among the three variations, T3 consistently achieved higher scores, particularly in taste and overall acceptability, suggesting improved consumer preference. The control sample maintained uniform high scores, while T1 and T2 showed moderate acceptance with slight variations across attributes. The enhanced sensory performance of T3 may be attributed to optimized formulation and ingredient balance (Lawless & Heymann, 2010). Overall, the results demonstrate that the developed product variants are organoleptically acceptable, with T3 being the most preferred.

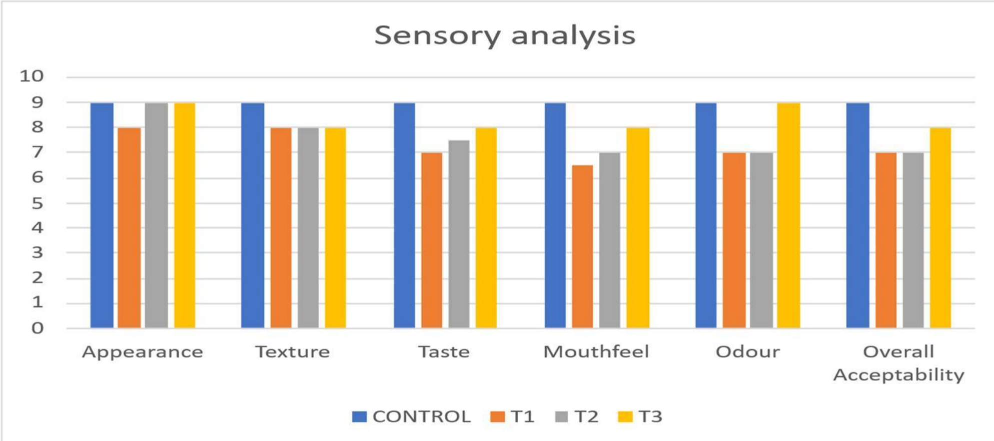


Fig: 3 Sensory Analysis Chart Table

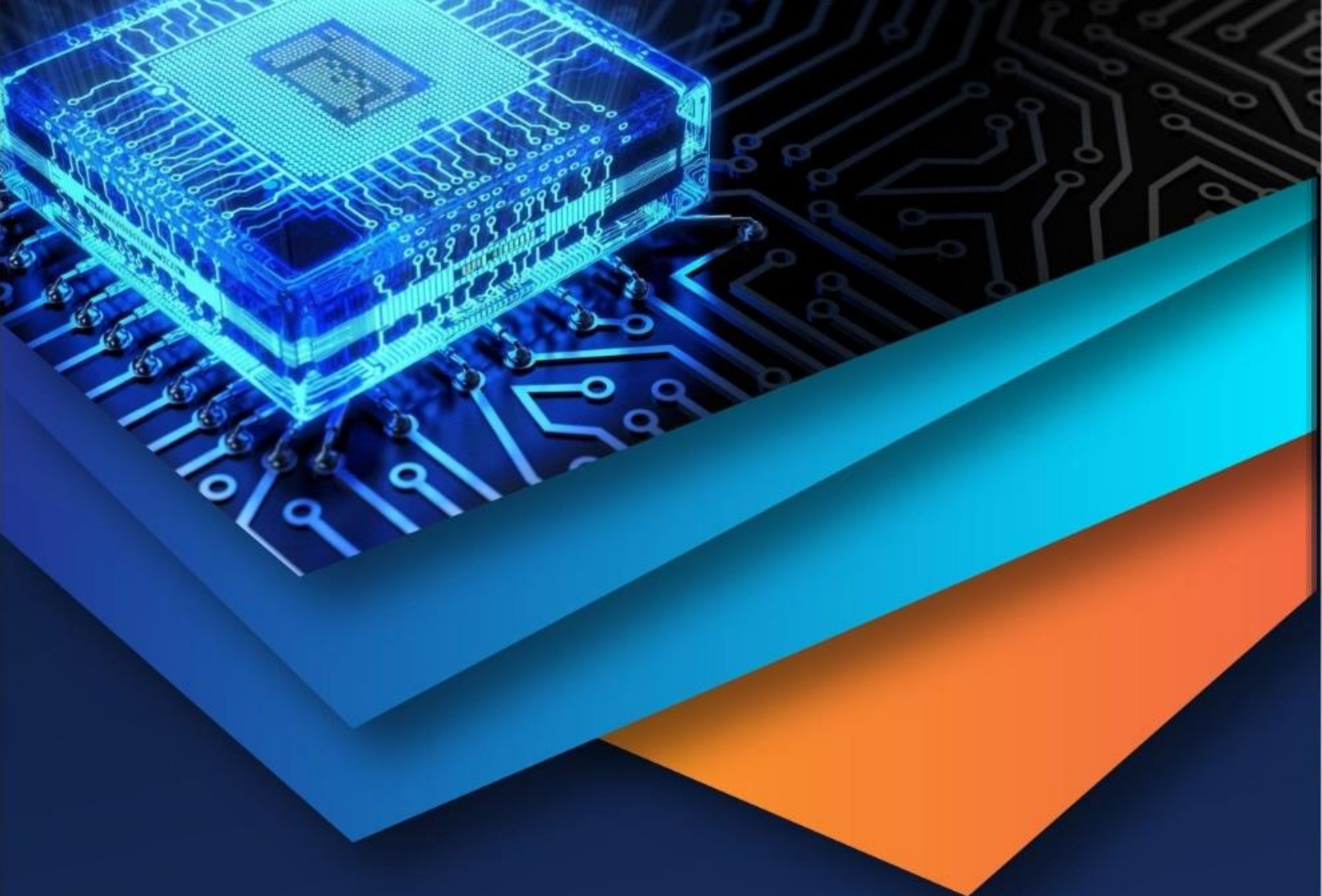
VI. CONCLUSION

The present study successfully developed a low-calorie sweet and sour gherkin chips pickle by incorporating non-nutritive sweeteners as partial or complete replacements for conventional sugar. The formulation process demonstrated that the combined use of stevia and erythritol can effectively deliver the desired sweetness while maintaining the characteristic flavor profile of traditional pickles. The inclusion of vinegar, salt, and calcium chloride contributed to product stability, preservation, and texture enhancement, ensuring that the final product met acceptable quality standards. Physico-chemical analysis confirmed that the developed pickle exhibited suitable pH, titratable acidity, and proximate composition, indicating good shelf stability and safety. Sensory evaluation revealed that among the different formulations, Trial 3 was found to be the most acceptable in terms of taste, texture, and overall palatability. The optimized formulation achieved a balanced sweet and sour profile without the bitterness or aftertaste often associated with certain non-nutritive sweeteners, demonstrating the effectiveness of ingredient optimization. Overall, the study highlights the potential for developing healthier, low-calorie alternatives to conventional pickled products without compromising quality or consumer acceptance. The successful use of stevia and erythritol in gherkin pickle formulation opens new opportunities for innovation in functional and diet-friendly foods.

REFERENCES

[1] AOAC (2019). Official Methods of Analysis (21st ed.). Association of Official Analytical Chemists.
[2] Battcock, M., & Azam-Ali, S. (1998). Fermented Fruits and Vegetables: A Global Perspective. FAO.
[3] BIS (2012). Indian Standards for Microbiological Analysis. Bureau of Indian Standards.
[4] Desrosier, N. W., & Desrosier, J. N. (1977). The Technology of Food Preservation. AVI Publishing.
[5] Fellows, P. J. (2009). Food Processing Technology: Principles and Practice (3rd ed.). Woodhead Publishing.
[6] FSSAI (2016). Manual of Methods of Analysis of Foods. Food Safety and Standards Authority of India.
[7] Frazier, W. C., & Westhoff, D. C. (2004). Food Microbiology (4th ed.). Tata McGraw-Hill.
[8] Jay, J. M., Loessner, M. J., & Golden, D. A. (2005). Modern Food Microbiology (7th ed.). Springer.
[9] Kumar, P., & Joshi, V. K. (2017). Vegetable Preservation and Processing.
[10] Livesey, G. (2003). Health potential of polyols as sugar replacers. British Journal of Nutrition, 89(S1), S31–S45.
[11] Livesey, G. (2003). Health potential of polyols as sugar replacers. Nutrition
[12] Meilgaard, M., Civille, G. V., & Carr, B. T. (2007). Sensory Evaluation Techniques (4th ed.). CRC Press.
[13] M. Grembecka, 20th ed., 2016H "Natural sweeteners in food," European Food Research and AOAC International, Official Methods of Analysis, 20th ed., 2016H.
[14] Potter, N. N., & Hotchkiss, J. H. (1995). Food Science (5th ed.). Springer.
[15] Rahman, M. S. (2007). Handbook of Food Preservation (2nd ed.). CRC Press.
[16] Robinson, R. W., & Decker-Walters, D. S. (1997). Cucurbits. CAB International.
[17] Ranganna, S. (2010). Handbook of Analysis and Quality Control for Fruit and Vegetable Products. Tata McGraw-Hill.
[18] Robertson, G. L. (2016). Food Packaging: Principles and Practice (3rd ed.). CRC Press.
[19] R. F. McFeeters, "Calcium chloride effects on pickled vegetables," Journal of Food Science, vol. 69, no. 4, pp. FCT134–FCT137, 2004.[5] United States Department of Agriculture, Complete Guide to Home Canning, 2015.
[20] Srinivasa Rao, N. K., Shivashankara, K. S., & Laxman, R. H. (2012). Cucumber (Cucumis sativus L.) and its cultivation. Indian Council of Agricultural Research.
[21] Stone, H., & Sidel, J. L. (2004). Sensory Evaluation Practices (3rd ed.). Academic Press.
[22] T. Lawless and H. Heymann, Sensory Evaluation of Food: Principles and Practices. Springer, 2010.

[23] USDA (2020). Nutritional Database for Standard Reference. United States Department of Agriculture.
[24] USDA (2020). Food Data Central Database. United States Department of Agriculture.
[25] Y. H. Hui, 2010.Handbook of Vegetables and Vegetable Processing. Wiley, 2010.



10.22214/IJRASET

INDEX COPERNICUS

45.98

IMPACT FACTOR: 7.129

TOGETHER WE REACH THE GOAL

IMPACT FACTOR: 7.429

INTERNATIONAL JOURNAL FOR RESEARCH

IN APPLIED SCIENCE & ENGINEERING TECHNOLOGY