

Organoleptic, Physico-Chemical and Nutritional Parameters of Gherkin Pickles Prepared with Indian Spices

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Abstract

India is regarded as the 'Home of Spices'. A large proportion of the spices imported globally every year comes from India. Use of such spices in traditional foods like pickles occupies an important place among the processed foods in India. India is the second largest vegetable producer in world. Hence, processing of vegetables with traditional Indian spices has good scope for the trade development overseas. Different variants of gherkin (*Cucumis anguria*) pickles were developed using traditional Indian spices available locally. The pickles were packed in glass jars through aseptic packing technology by vacuum sealing and pasteurization. The developed pickles were studied for the physico-chemical properties and sensory attributes soon after pasteurization and after 15 days of stabilization period. Further, the effect of heat treatment/pasteurization on the nutritional profile of the developed pickles after 15 days of stabilization period was studied. The study showed that use of spices in either fresh or dehydrated form, enhanced the sensory profile of gherkin pickles. The four variants of spice based pickles developed, were well accepted among the panelist pre- and post-stabilization. The addition of spices enhanced the nutrient content of the pickles when compared with plain gherkin vegetables. Though this study focused only on gherkin pickles, Indian spices can be very well explored in other vegetable products that can be processed and stored for longer time.

Keywords: Gherkin; Spice; Vacuum Sealing; Pasteurization; Osmosis; Stabilization.

Introduction

Processed vegetables account for approximately 42-45 million tons of the total world production and undergo varying degree of processing. However, in Asia, vegetables are mainly processed for preparing pickles. The main suppliers of Asian vegetables to export market for processing are India, China, Thailand and Vietnam [1].

Presently, India is listed second for the vegetables production in the world. The production of vegetables in India has touched 295 MT (2015-16), from about 145.8 MT in 2001-02 [2]. Owing to the fact that India is the second largest vegetable producer, every year large quantities of vegetables are wasted due to lack

of proper and protected storage. This can be very well prevented using different processing and preservation technology. This will help in storing the vegetables for longer time and they can also be exported to other countries. One such vegetable which has emerged as a potential export-oriented delicacy is the 'gherkin', popularly known as 'pickling cucumber'. This vegetable alone has the potential of fetching foreign exchange worth Rs. 1,500 million from 50,000 tons of produce every year. Today it is the only 100% export-oriented commodity from the country [3].

The history and culture of Indian spices and condiments are probably as old as human civilization itself. In spite of the industrial advancement of India in modern times, this country is still regarded as the 'Home of Spices'. This is due to the fact that the quality of the spices produced in and exported from this country continues to be the best. An impressive 46% of the spices imported globally every year, comes from India.

While India exports processed gherkins and spices separately to the global market, the possibility of exporting both together in processed form is not

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explored in a systematic way so far by the Indian gherkin industries. Hence, in present investigation, an effort is put to study the processing aspects of gherkins/cucumber pickling in combination with Indian spices in vacuum sealed glass jars. The emphasis is placed on the development and standardization of spice based gherkin pickles keeping in view the organoleptic parameters associated with Indian spices. The study further details the physico-chemical and nutritional parameters of the developed pickles with added spices in fresh and dehydrated form.

various spices like onion, garlic, dill leaves, dry red chili, black pepper, cumin seeds and yellow mustard. While fresh spices were obtained locally from the farmers in and around Bangalore, the dry and dehydrated spices were procured from the approved traders in India. Pickles generally contain ingredients such as salt, vinegar, sugar, spices and water as described by Sandhu and Shukla (1996) [4]. For this study, those ingredients such as salt, calcium chloride, natural vinegar, and colour were procured from the industrial supply shop and were of food grade nature.

Materials and Methods

Materials

Selection of Raw Materials

Ajax variety of the Gherkins (*Cucumis anguria*), were selected for the pickles/ product development with

Methods

Steps in Processing

Various steps associated in pickling process was described and discussed in detail by Cruess [5]. For this study, similar steps were adopted for the processing of gherkins with spices after the harvest

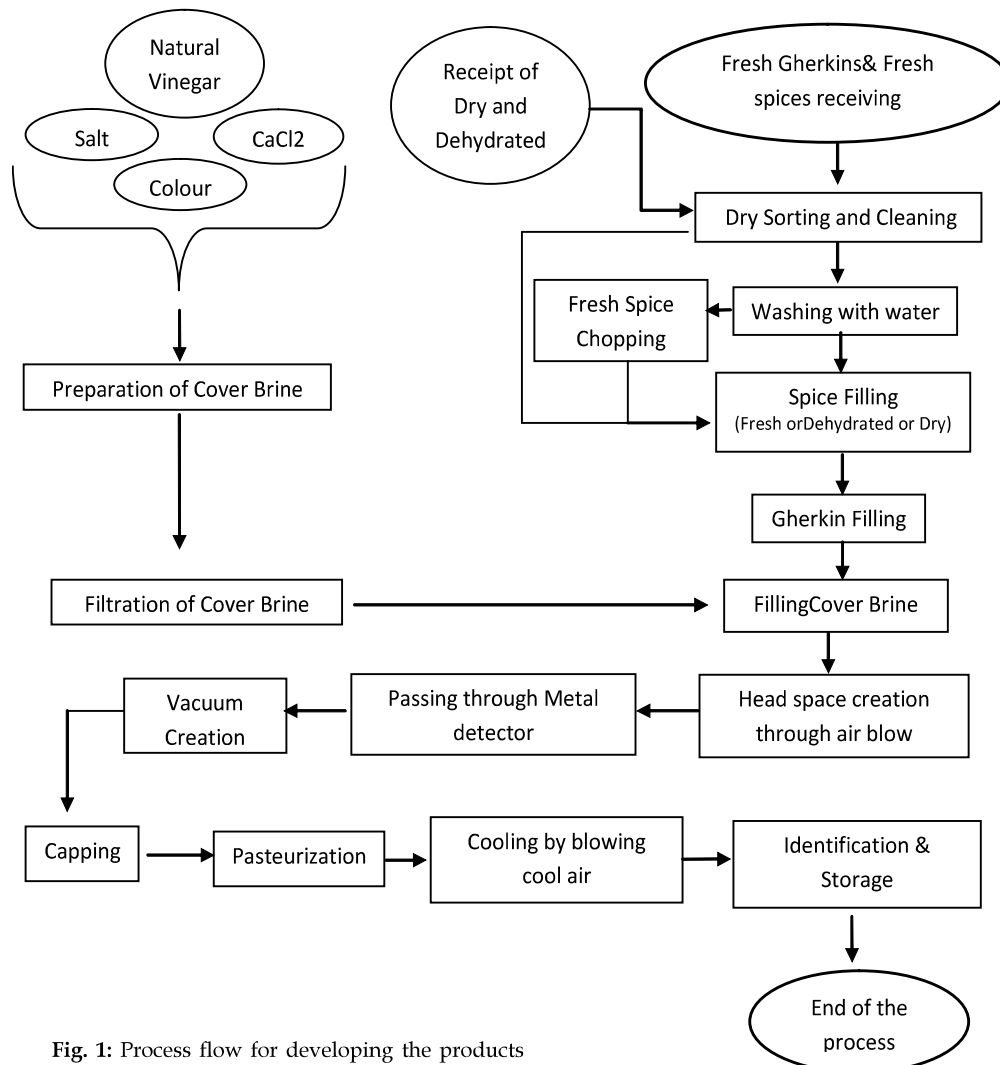


Fig. 1: Process flow for developing the products

as given in Figure 1 and are detailed below.

Reception: To ensure less time spent on the transportation, fresh gherkins were received directly from the farmers within 60 to 80 km periphery of the industry. Further the gherkins were stored in controlled temperature and processed within 24 hours of the harvest to avail the benefit of maximum freshness. The fresh dill leaves, onions and garlic were procured early morning on day of processing directly from the farmers or traders and were stored in the cold storage (between 8°C to 15°C) till further processing.

The dehydrated and dry spices and other ingredients (salt, calcium chloride, natural vinegar, and colour) were inspected for the quality parameters and stored till further processing.

Washing: Washing of the freshly harvested gherkins and dill leaves were done using water to remove soil. Gherkins were checked visually for any mold infection or bruises. The dill leaves were sorted out by removing the roots and weeds prior to washing and cutting. Fresh onions and garlic were sorted out to remove the rotten and fungus infected ones followed by peeling, washing and chopping.

Gherkin Selection: The washed gherkins were inspected on a conveyer belt to sort out crooked and bent vegetable and to remove flowers, stalks, damaged and infected vegetable. Clean, fresh, good green gherkins were selected for further processing.

Grading: Grading of gherkin is carried out on the basis of count per kg. The grade of 60/80 (count per kg was an average of 60 to 80 gherkins), was selected for this study.

Packaging Container: 500ml capacity of glass jars and metal caps of 77 mm diameter with food grade liner were selected to pack the gherkin pickles.

Cover Brine Preparation: Acidic media or cover brine having pH less than 3.2, is used as preservative for pickles to enhance the taste of the product. For this study, cover brine was prepared using potable water as stated by Sandhu *et al.* [4] with natural vinegar (13% pure acetic acid), salt, colour and calcium chloride which is used as firming agent to ensure crispiness post pasteurization [6].

Capping: The capping of the jars was done automatically by the Capping machine (model-EMRITO 2.8 and Make-Spain). A minimum 100 mbar vacuum was maintained to ensure long product shelf life when combined with an effective pasteurization process.

Pasteurization: The optimum processing conditions

for pasteurization at a process temperature of 70°C was proposed by Rodrigo and Alvarruiz [7]. The products developed for all the variants were pasteurized between 80 to 85°C for 12 to 18 min to obtain the minimum *core temperature* of the gherkin at 70°C, as suggested by Rodrigo and Alvarruiz [7] to inhibit/eliminate the viable microbial load (pathogens).

Core Temperature: The maximum temperature achieved at the cold spot of a gherkin while the pickle jars are passed through the hot zone of the pasteurizer is called the '*core temperature*'. The cold spot is the center point between 2/3rd distance from the gherkin tip and 1/3rd from the bottom of the gherkin. This is the point where the minimum temperature is checked to ensure the effective pasteurization that kills viable microbial load.

QA Check

Product Development

New products were developed keeping 'spice/s' as important ingredients in all formulations. Total four variants of pickled gherkins were developed (Table 1) out of which three variants were developed using Dill leaves and spices in fresh and dehydrated form. One variant was developed without dill leaves but using other commonly consumed Indian spices like cumin seeds, whole black pepper and dry red chili.

For standardization, each of the formulation mentioned above were subjected to 5-7 trials till an acceptable product evolved. The criteria of colour, texture and the overall acceptance was considered for standardizing the formulations. For each spice variant, a total of 36 jars were produced in every trial.

Quality Control and Laboratory Analysis

Quality Control is an important aspect in gherkin pickling and consists of the steps like cover brine preparation, physical checking, organoleptic evaluation and laboratory analysis. All these parameters were evaluated soon after the packing and pasteurization and also after the stabilization period of 15 days from the date of packing.

Physical Analysis: The pickled gherkins were evaluated for correct grade, gherkin count per jar, spice quantity, vacuum, head space and cap security.

Chemical Analysis: The methods defined by Ranganna [8] were adopted to analyze the chemical parameters like pH, acidity as acetic acid, salt and calcium quantity in ppm.

Nutrient Analysis: Uthpala et al [9], studied the proximate and mineral composition of locally grown gherkin varieties. A similar effort was taken to study the proximate parameters (energy, carbohydrate, protein and fat) and the vitamin C and Calcium content of the developed pickles after 15 days of stabilization period, following AOAC [10] methods.

Organoleptic Evaluation

Few studies have been conducted on the development of the terms or descriptors used to describe pickle flavour and the other sensory parameters responsible for the characteristic pickle taste and aroma. One such study was conducted by Zhuk[11], who described a method based on 5-point scale for panel evaluation of organoleptic quality of pickled cucumber. Similar method was adopted to evaluate the sensory attributes like colour, texture, crispiness and flavour profile of the developed pickles.

Statistical Analysis

The data of nutritional analysis were considered in triplicates for analyzing the mean and standard deviation. Similarly, the results of sensory evaluation were subjected to statistical analysis using Students T test between fresh and stabilized samples fixing the probability level of 0.05. The values represent mean and standard deviation of analysis result and sensory scores respectively.

Result and Discussion

The physico-chemical properties of the pickles developed with various spices, soon after the development and after a stabilization period of 15 days are listed in the Table 2 to Table 5. The level of the ingredients and additives/chemicals which are added to the media determines the process of pickling and preservation.

Physico-Chemical Properties of Gherkin Pickles with Various Spices

A. SP 1-Pickles with fresh spices (Dill leaves, Onion and garlic)

While same grade of gherkin (60/80) was used to pack all the jars, the count of the gherkins varied from jar to jar. The average count of gherkins per kg was 72.2 during the packing and an average of 19.6 numbers of gherkins was packed in each jar. The head

space was lower initially; however, it increased after stabilization. This is due to the osmosis process that takes place during the stabilization period, leading to loss of water from the gherkins and the same water is replaced by the vinegar based cover brine to result in the characteristic pickle flavour. There was an increase in calcium content post-stabilization, whereas acidity and pH recorded a decrease.

Aseptic / vacuum sealing is referred to as one of the many hurdle technologies in obtaining the microbial safety of pickled fruits and vegetables [12]. Vacuum or hypobaric packaging technique also acts as preservation technique [13]. The vacuum of the jars were initially kept constant at 100 mbar of Hg at the time of development. However, the same increased to nearly 3 times high with an average vacuum of 280mbar after stabilization. An increase in the vacuum is a proof for a tamper proof aseptic sealing.

Kuwahara *et al.* [6] reported that addition of calcium chloride to cucumber pickles increased firmness to direct proportions to calcium level present in the pickles. In the present study, the calcium level increased from 351 to 473 ppm indicating the natural source of calcium content contributed by gherkins and the spices.

B. SP-2-Pickles with dehydrated spices (Dill leaves, Onion and garlic)

A slightly different trend was observed in the physico-chemical parameters of the pickles when packed with the same spices but in the dehydrated form. The detailed parameters are listed in Table 3.

While a maximum 100m bar vacuum was found in fresh pickle, the stabilized jar had maximum of 250 mbar vacuum. There was reduction in the acidity content from 0.8% to 0.71%. The calcium content increased significantly. The pH of the product was initially 4.0 and reduced to 3.83 after stabilization. As noted earlier, these changes signify the process of osmosis in pickles and indicate stabilization.

C. SP-3-Pickles with cumin seeds, dry pepper and dry red chilli.

Table 4 shows the Physico-chemical parameters of the gherkin pickles made with cumin seeds, dry pepper and dry red chili. While there was a combination of increased and decreased levels of different parameters observed in the two variants of pickles mentioned above, for this particular variant, the levels were decreased after the pickles were stabilized for a period of 15 days.

The acidity and salt levels were reduced to 0.62%

and 1.12% from 0.74 % and 1.23% respectively. The pH of the product decreased from 4 to 3.8 signifying the process of osmosis in pickles and indicating stabilization.

D. SP-4-Pickles with dehydrated dill leaves, yellow mustard and fresh onion

This is the only variant which was tried with a combination of spices in all three forms. While the dill leaves used were in dehydrated form, there was fresh onion and dry yellow mustard used in this variant of pickles. The physico-chemical parameters are presented in Table 5. Like other variants, the parameters like acidity and salt decreased from 0.71% and 1.30% to 0.63% and 1.18% respectively. Head space decreased from 10.6 mm to 8.6mm. In the present study, the calcium level increased from 299 to 457 ppm adding to the product crispiness as reported by the study conducted by Kuwahara *et al.* [6].

Sensory attributes of Gherkin Pickles

Consumer acceptance of the freshly packed gherkin pickles is very much dependent on the organoleptic criteria in the overseas market. The main sensory attributes of gherkin pickles are recognized as the colour, crunchy bite/crispiness and the overall flavour profile. This is because, some vegetables used in pickling are very heat sensitive and quality indicators such as colour and texture are usually degraded to a large extent during thermal treatment or pasteurization process [14]. Further Fresh cucumber pickles especially when refrigerated, develop a characteristic flavour. The investigative study by Harris *et.al* (2002) [15] have demonstrated a strong dependence between product pH and the ability of refrigerated cucumber to produce flavor components that characterize fresh cucumber flavor. India is considered as the “Home of Spices” and every spice in India is known for its unique aroma and flavour components. Addition of spices imparts

Table 1: Details of Formulations of Spice variant Gherkin pickles

SP1	SP2	SP3	SP4
Gherkins	Gherkins	Gherkins	Gherkins
Water	Water	Water	Water
Salt	Salt	Salt	Salt
Vinegar	Vinegar	Vinegar	Vinegar
Calcium Chloride	Calcium Chloride	Calcium Chloride	Calcium Chloride
Color	Color	Color	Color
Fresh Dill leaves	Dehydrated dill leaves	Cumin seeds	Dehydrated dill leaves
Fresh Onion	Dehydrated onion	pepper	Yellow mustard
Fresh Garlic	Dehydrated garlic	Dry red chilly	Fresh Onion

Table 2: Physico-chemical properties of fresh and stabilized product: Spice Variant 1 (SP 1)

Properties	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Mean
Freshly prepared products						
Grade	60/80	60/80	60/80	60/80	60/80	60/80
Count Per Kg in No.	73	71	73	73	71	72.2
Vaccum in mbar	100	100	100	100	100	100
Security in mm	5	6	5	5	6	5.4
Head Space in mm	9	8	9	9	10	9
Acidity in %	0.66	0.66	0.66	0.6	0.66	0.65
Salt in %	1.34	1.28	1.28	1.34	1.34	1.3
Calcium in ppm	333	335	380	375	331	351
pH	4.1	3.87	3.87	3.91	4.1	4
Stabilized Products after 15 days						
Grade	60/80	60/80	60/80	60/80	60/80	60/80
Count Per Jar in No.	20	19	20	20	19	19.6
Vaccum in mbar	300	250	300	300	250	280
Security in mm	6	7	7	7	6	6.6
Head Space in mm	7	12	10	10	9	9.6
Acidity in %	0.6	0.6	0.6	0.66	0.6	0.6
Salt in %	1.28	1.28	1.34	1.34	1.28	1.3
Calcium in ppm	481	481	481	442.1	481	473
pH	3.7	3.74	3.81	3.83	3.71	3.76

Table 3: Physico-chemical properties of fresh and stabilized product: Spice Variant 2 (SP 2)

Properties	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Mean
Freshly prepared products						
Grade	60/80	60/80	60/80	60/80	60/80	60/80
Count Per Kg in No.	73	72	72	72	73	72.4
Vaccum in mbar	100	100	100	100	100	100
Security in mm	6	7	7	7	7	6.8
Head Space in mm	10	11	11	12	11	11
Acidity in %	0.86	0.78	0.78	0.86	0.78	0.8
Salt in %	1.34	1.28	1.28	1.22	1.34	1.3
Calcium in ppm	285	302	288	285	285	289
pH	4	4	3.97	3.91	4	4
Stabilized Products after 15 days						
Grade	60/80	60/80	60/80	60/80	60/80	60/80
Count Per Jar in No.	21	20	20	22	20	20.6
Vaccum in mbar	250	200	250	300	250	250
Security in mm	6	6	7	6	6	6.2
Head Space in mm	8	8	10	8	8	8.4
Acidity in %	0.72	0.72	0.66	0.72	0.72	0.71
Salt in %	1.28	1.34	1.22	1.28	1.22	1.27
Calcium in ppm	481.2	444.1	481.2	442.1	444.1	458.5
pH	3.83	3.84	3.73	3.84	3.93	3.83

Table 4: Physico-chemical properties of fresh and stabilized product: Spice Variant 3 (SP 3)

Properties	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Mean
Freshly prepared products						
Grade	60/80	60/80	60/80	60/80	60/80	
Count Per Kg in No.	72	74	72	70	73	72.2
Vaccum in mbar	75	100	100	75	100	90
Security in mm	6	7	7	6	6	6.4
Head Space in mm	10	9	10	11	9	9.8
Acidity in %	0.72	0.78	0.78	0.72	0.72	0.74
Salt in %	1.22	1.22	1.22	1.22	1.28	1.23
Calcium in ppm	302	302	288	288	285	293
pH	3.91	4	4.03	3.91	4	4
Stabilized Products after 15 days						
Grade	60/80	60/80	60/80	60/80	60/80	
Count Per Jar in No.	20	21	21	21	21	20.8
Vaccum in mbar	350	300	350	350	250	320
Security in mm	6	6	7	6	6	6.2
Head Space in mm	8	8	10	8	8	8.4
Acidity in %	0.6	0.6	0.66	0.66	0.6	0.62
Salt in %	1.11	1.11	1.11	1.14	1.14	1.12
Calcium in ppm	441	481	481.2	441	444.1	457.6
pH	3.84	3.73	3.9	3.83	3.72	3.80

characteristic flavour to the dishes made. While consumers relate the flavour profile of traditionally made pickles loaded with spices, very few studies are conducted on the addition of spices to the gherkin pickles and the impact on the flavor components of the pickles.

The developed pickles with various Indian spices were evaluated by skilled and semi-skilled panelists (employed with the gherkin processing Industry) for the attributes like texture, colour, flavour and crispiness based on the 5-point scale method

described by Zhuk (1991) [11]. The retention of characteristic texture, flavour and crispiness after the completion of osmosis process post 15 days of stabilization was a challenge as there are many instances reported overseas on the rejection of pickles at retail level, due to improper texture or flavor or due to sogginess. The present study confirmed that the flavour of cucumber pickle products varies widely, depending upon the type of spices and the form in which the spices are added to the final product, as identified earlier by Fleming *et al.* [16].

Table 5: Physico-chemical properties of fresh and stabilized product : Spice Variant 4 (SP 4)

Properties	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	Mean
Freshly prepared products						
Grade	60/80	60/80	60/80	60/80	60/80	
Count Per Kg in No.	75	72	73	72	71	72.6
Vaccum in mbar	100	100	100	100	100	100
Security in mm	7	6	7	7	7	6.8
Head Space in mm	10	11	11	10	11	10.6
Acidity in %	0.72	0.72	0.66	0.72	0.72	0.71
Salt in %	1.34	1.34	1.28	1.28	1.28	1.30
Calcium in ppm	302	302	302	288	302	299
pH	3.87	3.84	3.91	3.91	3.84	3.87
Stabilized Products after 15 days						
Grade	60/80	60/80	60/80	60/80	60/80	
Count Per Jar in No.	19	20	21	19	19	19.6
Vaccum in mbar	150	250	150	250	250	210
Security in mm	7	6	7	7	6	6.6
Head Space in mm	7	9	10	7	10	8.6
Acidity in %	0.66	0.66	0.6	0.66	0.6	0.63
Salt in %	1.22	1.22	1.14	1.14	1.22	1.18
Calcium in ppm	481.2	441.1	441.1	481.2	441	457
pH	3.82	3.9	3.76	3.74	3.78	3.8

Table 6: Sensory attributes of Fresh and Stabilized Products

Day	Trial 1	Trial 2	Trial 3	Trial 4	Trial 5	
SP 1						
Colour	0	4.00 ± 0.286	4.00 ± 0.085	3.9 ± 0.35	4.00 ± 0.252	4.00 ± 0.244
	15	4.00 ± 0.115 ^{ns}	3.2 ± 0.316 ^{***}	3.5 ± 0.408 ^{ns}	4.00 ± 0.183 ^{ns}	4.00 ± 0.085 ^{ns}
Texture	0	3.8 ± 0.27	4.00 ± 0.23	4.00 ± 0.15	3.5 ± 0.15	4.0 ± 0.28
	15	3.9 ± 0.21 ^{ns}	3.8 ± 0.29 ^{ns}	3.8 ± 0.39*	4.5 ± 0.18 ^{***}	4.5 ± 0.13 ^{***}
Crispiness	0	3.8 ± 0.23	3.8 ± 0.27	3.5 ± 0.42	4 ± 0.3	4.00 ± 0.21
	15	4.00 ± 0.08 ^{**}	3.4 ± 0.44	4.5 ± 0.2 ^{**}	4.00 ± 0.28 ^{ns}	4.00 ± 0.28 ^{ns}
Flavour	0	3.5 ± 0.32	4.2 ± 0.27	4.5 ± 0.13	4.00 ± 0.12	4.5 ± 0.13
	15	3.90 ± 0.33 ^{**}	3.8 ± 0.32 ^{**}	4.00 ± 0.17 ^{***}	4.2 ± 0.23*	4.2 ± 0.25 ^{***}
SP 2						
Colour	0	3.8 ± 0.3	3.8 ± 0.21	3.9 ± 0.27	4.00 ± .22	4.00 ± 0.20
	15	4.00 ± 0.31*	4.20 ± 0.3 ^{***}	4.0 ± 0.34 ^{ns}	4.00 ± 0.22 ^{ns}	4.00 ± 0.08 ^{ns}
Texture	0	3.3 ± 0.36	3.8 ± 0.35	3.8 ± 0.35	4.00 ± 0.31	4.00 ± 0.46
	15	4.0 ± 0.08 ^{***}	3.5 ± 0.33 ^{**}	4.5 ± 0.09 ^{***}	4.0 ± 0.15 ^{ns}	4.50 ± 0.11 ^{***}
Crispiness	0	3.5 ± 0.09	3.50 ± 0.27	3.50 ± 0.36	3.5 ± 0.24	4.0 ± 0.22
	15	4.00 ± 0.13 ^{***}	4.0 ± 0.3 ^{***}	4.00 ± 0.2 ^{***}	4.00 ± 0.35 ^{***}	4.00 ± 0.27 ^{ns}
Flavour	0	3.50 ± 0.32	4.2 ± 0.21	4.0 ± 0.28	4.00 ± 0.20	4.00 ± 0.07
	15	3.0 ± 0.27 ^{***}	3.5 ± 0.32 ^{***}	4.00 ± 0.23 ^{ns}	4.0 ± 0.09 ^{ns}	4.0 ± 0.18 ^{ns}
SP 3						
Colour	0	4.00 ± 0.0.3	4.5 ± 0.21	4.5 ± 0.13	4.0 ± 0.22	4.0 ± 0.22
	15	4.00 ± 0.21 ^{ns}	4.2 ± 0.23 ^{**}	4.0 ± 0.0.31 ^{***}	4.00 ± 0.31 ^{ns}	4.00 ± 0.23 ^{ns}
Texture	0	4.0 ± 0.31	4 ± 0.33	3.8 ± 0.32	4.0 ± 0.30	4 ± 0.29
	15	4 ± 0.08 ^{ns}	3.5 ± 0.32 ^{**}	4.5 ± 0.05 ^{***}	4.0 ± 0.21 ^{ns}	4.5 ± 0.14 ^{***}
Crispiness	0	4.00 ± 0.31	3.5 ± 0.36	3.5 ± 0.36	3.50 ± 0.33	4.00 ± 0.30
	15	4.00 ± 0.20 ^{ns}	4.0 ± 0.28 ^{**}	4.00 ± 0.36 ^{**}	4.00 ± 0.31 ^{**}	4.00 ± 0.22 ^{ns}
Flavour	0	4.0 ± 0.23	4.2 ± 0.23	4.00 ± 0.22	4.5 ± 0.15	4.00 ± 0.19
	15	3.00 ± 0.42 ^{***}	3.5 ± 0.24 ^{***}	4.0 ± 0.18 ^{ns}	4.0 ± 0.57 ^{***}	4.0 ± 0.18 ^{ns}
SP 4						
Colour	0	3.8 ± 0.22	3.5 ± 0.33	3.8 ± 0.27	4.00 ± 0.32	4.00 ± 0.05
	15	4.00 ± 0.27 ^{ns}	4.20 ± 0.29 ^{***}	4.00 ± 0.36 ^{ns}	4.00 ± 0.30 ^{ns}	4.00 ± 0.18 ^{ns}
Texture	0	3.5 ± 0.41	3.5 ± 0.30	3.5 ± 0.33	3.8 ± 0.24	3.5 ± 0.28
	15	4.00 ± 0.22 ^{**}	3.50 ± 0.23 ^{ns}	4.50 ± 0.0 ^{***}	4.00 ± 0.12*	4.50 ± 0.11 ^{***}
Crispiness	0	4.0 ± 0.31	3.50 ± 0.32	3.50 ± 0.36	4.0 ± 0.28	4.00 ± 0.30
	15	4.00 ± 0.31 ^{ns}	4.0 ± 0.14 ^{***}	4.0 ± 0.10 ^{***}	4.0 ± 0.35 ^{ns}	4.00 ± 0.31 ^{ns}
Flavour	0	3.8 ± 0.23	4.0 ± 0.22	4.00 ± 0.28	4.2 ± 0.23	4.00 ± 0.18
	15	3.00 ± 0.31 ^{***}	3.50 ± 0.30 ^{**}	4.0 ± 0.18 ^{ns}	4.0 ± 0.30 ^{**}	4.00 ± 0.08 ^{ns}

Values represent mean and standard deviation of sensory scores. The statistical differences are between fresh and stabilized product on application of Students T test. ***: P≤0.001; **: P≤0.01; *: P≤0.05; ns: not significant - P> 0.05.

Table 7: Nutritional composition of Spice variant Gherkin Pickles (per 100g)

Parameters	SP 1	SP2	SP3	SP4
Carbohydrate (g)	4.73 ± 0.028	4.78 ± 0.141	4.38 ± 0.169	4.33 ± 0.028
Protein (g)	1.26 ± 0.028	1.44 ± 0.024	1.13 ± 0.106	0.67 ± 0.035
Fat (g)	0.15 ± 0.014	0.26 ± 0.014	0.38 ± 0.017	0.53 ± 0.176
Vitamin C (mg)	4.24 ± 0.021	5.24 ± 0.021	5.19 ± 0.042	5.09 ± 0.127
Calcium (mg)	44.19 ± 0.247	46.71 ± 0.134	45.3 ± 0.707	51.5 ± 0.707
Energy (Kcal)	25.3 ± 0.070	27.2 ± 0.282	24.99 ± 0.926	24.58 ± 0.671

Values represent mean and standard deviation of sensory scores.

Table 6 shows the comparison between the overall sensory score of the freshly prepared pickles with spices and the same pickles post 15 days of stabilization period. The sensory scores for various sensory characteristics were varying for individual trials and were very much dependent on the ratings given by the panelists. For the spice variant 1, where the pickles were prepared using fresh spices (dill leaves, onion and garlic), the colour difference was non-significant in almost all the trials taken to standardize the product. However, the difference was very much significant for the flavour characteristic of pickles freshly packed and the same pickle after 15 days of stabilization period. This study supported the findings of by Salashiniski *et al.* [17] whose study showed an improvement of flavour of pickled cucumber by the use of spices.

In case of the spice variant 2 (gherkin pickle with dill leaves, onion and garlic in dehydrated form), the same trend recorded for colour as that of SP1, where there was no significant difference observed in the colour of the freshly packed pickle and the stabilized pickle. The difference was significant for the flavour characteristic in the first two trials, but no significant difference noted in the subsequent trials. However, for this variant the difference was significant in many of the trials for the texture and the corresponding crispiness of the pickles when compared between the freshly packed with the pickles after 15 days of stabilization period. Under the spice variant 3 (SP3) and 4 (SP4), the pickles were packed along with cumin seeds, dry pepper, dry chilli, and dehydrated dill leaves, yellow mustard and fresh onion. These are the spices used daily in every Indian household. For both the variants, non-significant difference was found for the sensory attributes colour, flavour and crispiness for the products packed in the 5th / final trial. However, the only characteristic for which the difference was highly significant between the freshly packed and stabilized product of both the variants, was the texture of the product. This finding did not support the perception of the consumers who usually perceive texture with the 'crispiness' of the product.

Nutritional Profile of the Pickles Post 15 Days of Stabilization Period

Data on the proximate composition of edible portion of cucumber (*Cucumis sativus*) was reported by Gopalan *et al* (1982) [18]. Similarly, the composition of cucumber pickle by a number of workers, was appraised by Sandhu *et. al* (1996) [4] in relation to vitamins, sugars, proteins and minerals.

Through this study, an effort was made to understand the nutrition profile of the gherkin pickles, after the stabilization for 15 days period and the data is compiled in Table 7. The carbohydrate content of cucumber is 2.5% as reported by Gopalan *et.al.* [18]. In our study, when cucumber was processed with vinegar and various Indian spices, the carbohydrate content was found to be in the range of 4.33 to 4.78%.

The protein content was lowest (0.67) in the variant 4 where spices in combined forms were used to prepare the pickles. This result supported the study carried out by Alian *et al* (1979) [19], who reported the protein content of 0.7 in the pasteurized dill cucumber pickle. The total fat content was noted to be low in all four variants and was recorded between 0.15 to 0.53%. The Vitamin C content was highest (5.24mg/100g) in the variant 2 with dehydrated spices and surprisingly lowest in the variant 1 (4.24mg/100g) with the same spices, but in fresh form. This is because of the loss of the Vitamin C during washing and pasteurization of fresh spices, as Vitamin C is a water soluble vitamin and also sensitive to heat treatment.

Koli and Kulkarni (1973) [20] studied the calcium content of fermented cucumber pickles after 15 days of fermentation period and found reduction of calcium content at the end of 15 days. In the present study, almost same level of calcium found in all variants of pickles which was in the range of 44.19 to 51.5mg/100g. Sour pickles is low in calories. This statement was very well supported by the present study where all the four variants recorded low energy content of 25.3, 27.2, 24.9 and 24.5 kcal/100g for variants SP1, SP2, SP3 and SP4 respectively.

Summary and Conclusion

Although spices are used in many traditional pickles, their potential usage are not explored in the gherkin pickles. The processing of such gherkin pickles along with traditional spices is simple, less expensive but has huge potentiality to earn revenue in export market. The present study deals with the processing of gherkin pickles with various Indian spices and its impact on the physico-chemical, nutritional and the sensory profile of the pickles. The study shows that, use of various spices enhances the nutritional profile and texture profile of gherkin pickles and is very well accepted among the panelist. Presence of spices in the gherkin pickle did not change the colour of the pickles even after the completion of osmosis process post stabilization period. Though the present study focuses only on gherkin pickles, spices can be very well explored in other vegetables that can be processed and stored for longer time. While Indian spices are famous globally as such, use of these spices in various other food globally consumed, will give an opportunity to earn revenues and strengthen our farmer's economy.

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