

Original Research Article

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Effect of Processing Methods on Physico-Chemical Properties, Sensory Evaluations and Storage Studies of Cauliflower (*Brassica oleracea* L. var. *botrytis*) Pickle

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ABSTRACT

Cauliflower (*Brassica oleracea* L. var. *botrytis*) is an excellent source of nutrient and containing low calorie, low fat and zero cholesterol content. Prolonged cooking of cauliflower destroys majority of vitamins and it is associated with bad smell. Perishable nature of cauliflower forces the farmers to sell it at a very low price during the glut season. In this situation, pickle is one of the oldest and most successful methods for preservation of cauliflower. The cauliflower pickles were prepared by using three types cauliflowers i.e. fresh (raw), boiled, fried and three (B₁, B₂ and B₃) different proportions of spices with two replications. The prepared cauliflower pickles were packaged in air tight glass bottle. The different physico-chemical properties of cauliflower pickle such as moisture content, protein, vitamin C, ash content, pH and TSS were studied. The maximum values of moisture content 58.50 % (T₅), protein contents 5.86 g/100g (T₈), Vitamin C content 97.60 mg/100g (T₆), ash content 3.92 % (T₉) respectively and minimum values of moisture content 40.56 % (T₇), protein contents 4.97 g/100g (T₁), Vitamin C content 91.37 mg/100g (T₉), ash content 0.91 % (T₁) respectively. Increasing trend of pH and TSS values were observed with increasing storage period. The significant variations were observed for appearance, aroma, texture, taste, colour and overall acceptability. It also shows the sensory values for all properties were more than 5.00 up to 2 months storage periods. On the basis of storage studied of 0 months, 1 month, 2 months and 3 months on colour change, off flavour properties, texture and visual fungal growth of cauliflower pickles, the treatments T₈, T₉, T₆ and T₅ were observed better quality.

Keywords

Cauliflower (*Brassica oleracea* L. var. *botrytis*), pickle, Physico-chemical properties, Sensory evaluations, Storage studies

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Introduction

Cauliflower (*Brassica oleracea* L. var. *botrytis*) is an important major winter vegetables crop extensively grown worldwide including India. It is an annual plant that

reproduces by seed and only the head is eaten, the edible white flesh sometimes called "curd". It has high nutritional value and it is known as one of the healthiest plants on the planet. It is an excellent source of dietary fibers, vitamins C, K and vitamins of the B

group and minerals such as manganese, potassium and magnesium. Its white inflorescence as it is low calorie, low fat, zero cholesterol content (Madavi and Bhajbhujje, 2014). Its role in the diet is also thought to be significant in preventing cancer, heart disease and immune system functioning (Nishina *et al.*, 1991; Sauberlich, 1994; Wargovich, 2000 and Kaur and Kapoor, 2001). Some researchers state that its quality is related to stability of its fatty acids (Scalzo *et al.*, 2007; Sharma *et al.*, 2005). The storage-life is approximately 7 to 10 days at 5°C. Storage for more than 3 weeks or at temperatures higher than 0°C results in poor visual and sensory quality (Hardenburg *et al.*, 1986; Suslow and Cantwell, 1998; DeEll *et al.*, 2003; Scalzo *et al.*, 2007; Canan Ece Tamer, 2012).

Quality loss in fresh cauliflower includes undesirable odors, yellowing of the curd sharp increase in bitter taste, curd softening, and leaf wilting (Fjeldsenden *et al.*, 1981; Forbes and Chapman, 1989; Berrang *et al.*, 1990; Schonhof *et al.*, 2004; Hodges *et al.*, 2006; Canan Ece Tamer, 2012). Prolonged cooking of cauliflower destroys majority of vitamins and it is associated with sulphur like bad smell. Cooking of cauliflower more than 30 minutes, decreases its 75% of health benefits. In raw form, it is also mixed with green salad or its pieces are dipped into sauces. It is also used in the preparation of pickle or mixed pickle with other vegetables (Sharma *et al.*, 2005). Perishable nature of cauliflower forces the farmers to sell it at a very low price during the glut season. In this situation, appropriate processing techniques are needed to utilize the abundant supply of cauliflower to reduce the post harvest loss and to increase the period of its availability.

Food preservation usually involves preventing the growth of fungi, bacteria or any other micro-organisms, as well as retarding the

oxidation of fats that cause rancidity. Fermentation is a slow decomposition process of organic substances induced by microorganisms or enzymes that essentially convert carbohydrates to alcohols or organic acids (FAO, 1998). LAB fermented vegetables helps to enhance human nutrition with the attainment of balanced nutrition, providing vitamins, minerals, and carbohydrates (Yamano *et al.*, 2006). Pickling along with drying and dehydration is one of the oldest food preservation techniques (USDA, ERS 2007). The pickling is basically, conversion of sugar to acid by microorganisms that are lactic acid bacteria (LAB) (Nurul and Asmah, 2012). As sugar convert to the lactic acid the condition become acidic and inhibits the growth of pathogens and other non acidic tolerant microorganisms' especially aerobic spoilage microorganisms. As a result from pickling, the vegetable will have a longer shelf life, translucent appearance, firm texture and pickle flavour.

The cauliflowers are generally mixed with ingredients like salt, spices, and vegetable oils and are set to mature in moisture less medium. Sodium chloride is one of the most commonly employed agents for food conservation, allowing considerable increase in storage time by reducing water activity (Jamshidi *et al.*, 2008; Arghya Mani, 2017). The optimization of pickle quality depends on maintenance of proper acidity, salt concentration, temperature and sanitary conditions. Another distinguishing characteristic is a pH less than 4.6 which is sufficient to kill most bacteria.

There are a number of methods for the preservation of perishable items. Pickling is one of them. It can preserve perishable foods for months. Pickles can be obtained by plain immersion of raw, fried and blanched or pre-cooked pieces of vegetables. Antimicrobial

herbs and spices, such as mustard seed, garlic, cinnamon or cloves, are often added. If the food contains sufficient moisture, pickling brine may be produced simply by adding dry salt. Prepared cauliflower pickles were stored in the bottle and jars (Noor *et al.*, 2014). Pickles are mostly packed in glass bottles due to their rigidity, inertness, non-toxicity, durability, compatibility and indigenous availability.

The glass packaging imparts long shelf life to pickle due to its inertness and impermeability to moisture and gases (Gopal *et al.*, 1985; C. Chellaram, 2015). Natural fermentation at room temperature, by lactic acid bacteria, produces the required acidity. Pickles serve as appetizers and help in digestion by aiding flow of gastric juices. Pickles are generally consumed by everyone whether a child or old, a labour, or a rich man. It makes the dish or food taste better and generally acts as appetizer (Noor *et al.*, 2014).

The aim of this research was to determine the physico-chemical properties sensory evaluations and storage studies of cauliflower pickles having different ingredients. Because cauliflower was not utilized widespread in food industry, it is required to determine possibility of the production of cauliflower pickle as a value added product.

Materials and Methods

The fresh cauliflower and other spices ingredients were procured and collected from local market of Dediapada. The spices ingredients like salt (*sodium chloride*), Ginger (*Zingiber officinale*), Red chili, Turmeric (*Curcuma longa*), Cinnamon (*Cinnamomum verum*), Black pepper (*Piper nigrum*), Cardamom (*Elettaria cardamom*), Aniseed (*Pimpinella anisum*), Clove (*Syzygium Aromaticum*), Mustard (*Brassica nigra*), Vinegar (*acetic acid*), Mustard oil,

Sugar (*monosaccharides*) and Garlic (*Allium sativum*) were used for the preparations of pickles. Purchased spices were cleaned, dried, grind properly and packed in HDPE polythene bags for pickles preparations as per their requirement. In pickle production spices ingredients were played major role for pickle preparation. Fresh cauliflower was washed properly and cut into 2.5 cm long pieces. In order to inhibit enzymatic browning, they were blanched in hot water at 100 °C containing NaCl salt (0.6%) for 2-3 minutes.

Treatment details and experimental design

Different treatments details and experimental design with different combinations for preparation of cauliflower pickles were presented in Table.1.

Cauliflower sample

- A₁ = Fresh cauliflower pickle
- A₂ = Boiled cauliflower pickle
- A₃ = Fried cauliflower pickle

Ingredients proportions

B₁ = 250 g cauliflower, 40g of salt, 6g ginger, 6g red chili powder, 5g cinnamon, 3g cumin, 2g cardamom, 7g aniseed, 2g clove, 13g mustard, 30g vinegar, 30g sugar, 100 ml mustard oil, 6g garlic.

B₂ = 250 gm cauliflower, 45g of salt, 7g ginger, 8g red chili powder, 6g cinnamon, 4g cumin, 3g cardamom, 9g aniseed, 3g clove, 15g mustard, 35g vinegar, 40g sugar, 100 ml mustard oil, 10g garlic

B₃ = 250 gm cauliflower, 50g of salt, 9g ginger, 9g red chili powder, 8g cinnamon, 5g cumin, 4g cardamom, 11g aniseed, 4g clove, 16g mustard, 40g vinegar, 45g sugar, 100 ml mustard oil, 12g garlic

Cauliflowers pickle preparations methods

Methods for pickle preparations from fresh cauliflower

For preparing fresh cauliflower pickles first of all collect cauliflower into the local market and then washed. After washing removal of undesirable or unnecessary material of cauliflower and cutting into small pieces into 2.5 cm long. Cauliflowers were blanching into water for 2-3 minutes. After blanching sun drying process were carried out for period of one hour. Mixing the ingredients into cauliflower and mix well and fried mustard oil was mixed on cauliflower. After that pickle were filled into glass jar and kept for further analysis.

Methods for pickle preparations from boiled cauliflower

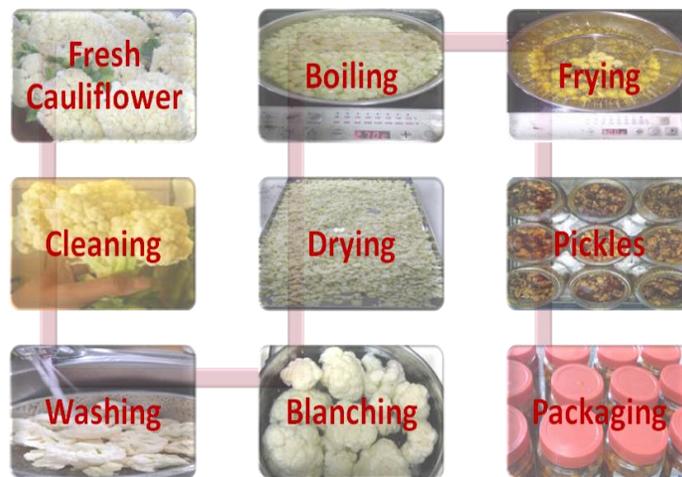
For preparing fresh cauliflower pickles first of all collect cauliflower into the local market and then washed. After washing removal of undesirable or unnecessary material of cauliflower and cutting into small pieces into 2.5 cm long. Cauliflowers were blanching into water for 2-3 minutes. After blanching

process, the cauliflower was boiled into water for 8-10 minutes. Then cauliflowers keep under sun drying for the period of one hour. Mixing the ingredients into cauliflower and mix well and fried mustard oil was mixed on cauliflower. After that pickle were filled into glass jar and kept for further analysis.

Methods for pickle preparations from fried cauliflower

For preparing fresh cauliflower pickles first of all collect cauliflower into the local market and then washed. After washing removal of undesirable or unnecessary material of cauliflower and cutting into small pieces into 2.5 cm long. Cauliflowers were blanching into water for 2-3 minutes. After blanching process the cauliflowers were fired into mustard oil at 100 °C up to slightly brownish color estimated time approx 5-6 minutes. After that the fried cauliflower were kept under sun drying for one hour. Mixing the ingredients into cauliflower and mix well and fried mustard oil is mixed on cauliflower. After that pickle were filled into glass jar and kept for further analysis.

Process Flow Chart for Pickles Preparations



Methodology used for analysis of pickle

Moisture content, protein, vitamin C, ash content, pH, and Total soluble solids (TSS) of different treatments of cauliflower pickle were studied and their details methodology were as under sub headings.

Moisture content

Moisture content of cauliflower pickle was calculated hot air oven methods (AOAC 1990). The samples were kept at 105 °C for 24 hours. Calculate the moisture content on a wet weight basis using following formula,

$$\text{Moisture content (\%)} = \frac{w_2 - w_3}{w_2 - w_1} \times 100$$

Where,

W_1 = Weigh of container

W_2 = Weigh of container with sample before dry

W_3 = Weigh of container with sample after dry

Protein content

The protein content of cauliflower pickle was determined by Lowry Method. In this method the reactivity of the peptide nitrogen with the copper ions under conditions and the subsequent reduction of the Folin-Ciocaltey phosphorus to hetero poly molybdenum blue by the copper catalyzed or aromatic acids.

Vitamin C

Vitamin C (also known as ascorbic acid) is abundant in vegetables and fruits. Vitamin C of cauliflower pickle was calculated by titration methods.

Ash content

The ash content of cauliflower pickle was calculated by muffle furnace using (AOAC 1990).

pH

pH is the measurement of the hydrogen ion concentration of a sample solution. It was calculated by digital pH meter using AOAC 1985.

Total soluble solids (TSS)

Total soluble solids (TSS) of cauliflower pickle in % or brix were determined by using a digital refractometer.

Sensory evaluation

Sensory analysis was performed in the Department of Processing and Food Engineering, at the College of Agricultural Engineering & Technology (CAET), Dediapada. Panellists were selected on the basis of their ability to discriminate and a scale a broad range of different attributes. A semi-trained panel of 10 students and from faculty of the Agricultural Engineering and technology of CAET, Dediapada evaluated the cauliflower pickle products for appearance, aroma, taste, colour and overall acceptability on a 9-point hedonic scale. Different sample of cauliflower pickle (fresh, boiled, fried) were presented to panellists for sensory evaluation. Panellists were provided with a glass of water and were instructed to rinse and shallow water between samples. They were given written instruction and asked to evaluate the products for acceptability based on its appearance, aroma, taste, texture, color and overall acceptability using the nine points hedonic scale (1= dislike extremely to 9= like extremely).

Storage studies

In storage studies pickles were stored in sealed in glass bottle at room temperature. The various properties like: pH, TSS, appearance, aroma, colour, texture, taste,

overall acceptability, colour change, off flavour and visual fungal growths for the different treatments of pickles were observed at a regular interval of one month up to three months storage period.

Results and Discussion

Physico-chemical properties of cauliflower pickle

Cauliflower pickles were prepared by fresh, boiling and frying of cauliflower with different combination of different spices. The prepared cauliflower pickles were packaged in air tight glass bottle. The results of the different physico-chemical properties such as moisture content of fresh cauliflower and cauliflower pickle, protein, vitamin C, ash content, pH and TSS are presented in Table. 2 and discussed in the subsequent paragraphs.

Moisture content

Moisture content of fresh cauliflower and prepared cauliflower pickles were determined by hot air oven method. The result of the average value of moisture content of fresh cauliflower and prepared cauliflower pickles for different treatment were presented in Fig 3.1.

From Fig. 3.1, it was observed the moisture content of cauliflower was varied in range of 87 % to 94 %. The maximum moisture content 93.58 % were found for fresh boiled cauliflower and the minimum moisture content 87.54 % were found for fried cauliflower. It may be due to in boiling process some moisture were added and in frying process some moisture reduced. The moisture content of cauliflower pickles were varied in range of 40 % to 59 %. The maximum values of moisture content 58.50 % of cauliflower pickles was observed for treatment T₅ and minimum values moisture

content 40.56 % was found for treatment T₇. Usha *et al.*, (1992) found that the safe moisture content in mango pickles to be as high as 61.0 % which is closed to the result obtained for cauliflower pickles.

Protein

Different treatments of cauliflower pickles were prepared and protein content of pickles were analysed by Lowry method. Results of the average values in two replications were presented in Fig 3.2.

From Fig. 3.2, it was observed that when we increased the spices ingredients in pickles, the protein content for different treatments cauliflower pickle were increased. In cauliflower pickle the maximum protein contents was found 5.86 g/100 g for treatment T₈ and minimum protein content was found 4.97 g/100 g for treatment T₁. It may be due to addition of spices ingredients in the pickles.

Vitamin C

Different treatments of cauliflower pickles were prepared and Vitamin C content were analysed and determined by titration method. The results of different treatments in two replication and average values were presented in Fig 3.3.

From Fig. 3.3, it is clear that the maximum Vitamin C content was found 97.60 mg/100 g for treatment T₆ and minimum Vitamin C content was found 91.37 mg/100 g for treatment T₉.

Ash content

Ash content for different combinations of prepared cauliflower pickles were determined by muffle furnace. And the results of average values were presented in Fig 3.4.

Table.1 Treatment details

Sr. No.	Cauliflower Sample	Ingredients proportions	Product	Treatments
1.	A ₁	B ₁	A ₁ B ₁	T ₁
2.		B ₂	A ₁ B ₂	T ₂
3.		B ₃	A ₁ B ₃	T ₃
4.	A ₂	B ₁	A ₂ B ₁	T ₄
5.		B ₂	A ₂ B ₂	T ₅
6.		B ₃	A ₂ B ₃	T ₆
7.	A ₃	B ₁	A ₃ B ₁	T ₇
8.		B ₂	A ₃ B ₂	T ₈
9.		B ₃	A ₃ B ₃	T ₉

Table.2 Physico-chemical properties of cauliflower pickle

Treatments	M.C. (Fresh Cauliflower), (%) (w.b.)	M.C. (Cauliflower Pickle), (%) (w.b.)	Protein (g/100 g)	Vitamin C (mg/100 g)	Ash content (%)
T ₁	92.50	46.81	<u>4.97</u>	96.75	<u>0.91</u>
T ₂	92.50	44.71	5.11	96.95	1.12
T ₃	92.50	49.69	5.17	96.93	1.08
T ₄	93.58	57.96	4.37	97.33	2.48
T ₅	93.58	<u>58.50</u>	5.85	96.33	2.39
T ₆	93.58	54.19	5.48	<u>97.60</u>	3.03
T ₇	87.54	<u>40.56</u>	5.58	95.71	3.61
T ₈	87.54	42.22	<u>5.86</u>	95.70	3.04
T ₉	87.54	41.63	5.62	<u>91.37</u>	<u>3.92</u>
Mean	91.21	48.47	5.33	96.07	2.40
CV (%)	0.07	18.29	0.62	21.09	1.49
SEM	0.0262	10.2988	0.0224	10.7603	0.0209
CD at 5%	0.0177	0.0115	0.0665	0.0997	0.0620
Test	Significant	Non Significant	Significant	Significant	Significant

Table.3 Variation in appearance of cauliflower pickles during storage periods

Sr. No.	Treatments	Appearance			
		0 Months	1 Month	2 Months	3 Months
1.	T ₁	6.37	6.92	6.42	4.06
2.	T ₂	6.82	6.51	6.65	4.11
3.	T ₃	7.02	6.81	6.52	4.03
4.	T ₄	6.94	6.72	6.11	4.15
5.	T ₅	6.42	6.76	6.34	4.02
6.	T ₆	6.8	6.84	7.21	3.80
7.	T ₇	6.02	6.63	6.38	5.15
8.	T ₈	6.91	7.02	6.24	4.28
9.	T ₉	6.57	6.42	7.01	4.20

Table.4 Variation in aroma of cauliflower pickles during storage periods

Sr. No.	Treatments	Aroma			
		0 Months	1 Month	2 Months	3 Months
1.	T ₁	6.87	6.91	6.31	4.04
2.	T ₂	6.56	7.07	6.14	4.31
3.	T ₃	6.52	6.91	6.41	4.09
4.	T ₄	6.63	6.94	6.36	4.73
5.	T ₅	6.82	7.07	6.84	4.55
6.	T ₆	6.41	7.11	7.12	4.07
7.	T ₇	6.11	7.09	6.61	5.35
8.	T ₈	7.16	6.94	6.62	4.00
9.	T ₉	6.62	5.81	7.42	4.08

Table.5 Variation in texture of cauliflower pickles during storage periods

Sr. No.	Treatments	Texture			
		0 Months	1 Month	2 Months	3 Months
1.	T ₁	6.21	6.94	6.74	4.01
2.	T ₂	6.42	6.91	6.25	4.46
3.	T ₃	7.01	7.54	7.09	3.97
4.	T ₄	6.91	6.71	6.79	4.09
5.	T ₅	6.14	6.75	6.61	4.85
6.	T ₆	6.41	7.21	7.21	4.29
7.	T ₇	6.66	6.84	6.01	5.05
8.	T ₈	6.81	6.52	6.25	4.33
9.	T ₉	6.54	6.21	6.25	3.84

Table.6 Variation in taste of cauliflower pickles during storage periods

Sr. No.	Treatments	Taste			
		0 Months	1 Month	2 Months	3 Months
1.	T ₁	5.83	6.27	6.42	4.08
2.	T ₂	5.56	6.45	6.45	4.17
3.	T ₃	6.13	6.61	6.90	4.11
4.	T ₄	5.91	6.84	6.84	3.95
5.	T ₅	6.24	6.94	7.31	4.23
6.	T ₆	7.17	7.02	6.92	3.75
7.	T ₇	5.8	7.55	6.71	3.29
8.	T ₈	7.26	6.83	6.82	4.05
9.	T ₉	6.33	5.70	7.42	4.31

Table.7 Variation in colour of cauliflower pickles during storage periods

Sr. No.	Treatments	Colour			
		0 Months	1 Month	2 Months	3 Months
1.	T ₁	6.13	6.57	6.93	3.85
2.	T ₂	6.50	6.71	6.71	4.05
3.	T ₃	7.24	7.12	6.63	3.56
4.	T ₄	7.42	7.15	6.73	5.02
5.	T ₅	6.70	7.22	7.14	4.19
6.	T ₆	6.56	6.51	7.24	4.00
7.	T ₇	6.32	6.77	7.24	4.89
8.	T ₈	6.82	6.32	6.84	3.77
9.	T ₉	6.61	6.44	6.53	4.25

Table.8 Variation in overall acceptability of cauliflower pickles during storage periods

Sr. No.	Treatments	Overall acceptability			
		0 Months	1 Month	2 Months	3 Months
1.	T ₁	6.28	6.72	6.43	5.52
2.	T ₂	6.37	6.73	6.50	4.14
3.	T ₃	6.78	6.99	6.72	3.26
4.	T ₄	6.76	6.87	6.45	5.68
5.	T ₅	6.46	6.94	6.91	6.04
6.	T ₆	6.67	6.93	7.06	3.95
7.	T ₇	6.18	6.97	6.73	4.25
8.	T ₈	6.99	6.72	6.75	5.13
9.	T ₉	6.53	5.99	7.25	3.71

Table.9 Storage studies of cauliflower pickles for the period of 0 months

Treatments	Colour change	Off flavour	Texture	Visual fungal growth	Remark
T ₁	No	No	Firm	No	Good
T ₂	No	No	Firm	No	Good
T ₃	No	No	Firm	No	Good
T ₄	No	No	Slightly soft	No	Good
T ₅	No	No	Firm	No	Good
T ₆	No	No	Firm	No	Good
T ₇	No	No	Firm	No	Good
T ₈	No	No	Firm	No	Good
T ₉	No	No	Firm	No	Good

Table.10 Storage studies of cauliflower pickles for the period of 1 month

Treatments	Colour change	Off flavour	Texture	Visual fungal growth	Remark
T ₁	No	No	Firm	No	Good
T ₂	No	No	Slightly soft	No	Good
T ₃	No	No	Slightly soft	No	Good
T ₄	No	No	Slightly soft	No	Good
T ₅	No	No	Firm	No	Good
T ₆	No	No	Firm	No	Good
T ₇	No	No	Soft	No	Good
T ₈	No	No	Firm	No	Good
T ₉	No	No	Firm	No	Good

Table.11 Storage studies of cauliflower pickles for the period of 2 months

Treatments	Colour change	Off flavour	Texture	Visual fungal growth	Remark
T ₁	No	No	Slightly Soft	No	Good
T ₂	No	No	soft	No	Good
T ₃	No	No	soft	No	Good
T ₄	No	Slightly	Soft	No	Good
T ₅	No	No	Slightly Soft	No	Good
T ₆	No	No	Slightly soft	No	Good
T ₇	No	Slightly	soft	Slightly	Slightly spoiled
T ₈	No	No	Firm	No	Good
T ₉	No	No	Firm	No	Good

Table.12 Storage studies of cauliflower pickles for the period of 3 months

Treatments	Colour change	Off flavour	Texture	Visual fungal growth	Remark
T ₁	No	No	Soft	No	Good
T ₂	No	Slightly	Soft	No	Good
T ₃	Yes	No	Soft	Yes	Slightly spoiled
T ₄	Yes	Slightly	Soft	No	Good
T ₅	Yes	Slightly	Slightly soft	No	Good
T ₆	No	No	Slightly soft	No	Good
T ₇	Yes	Slightly	Soft	Yes	Slightly spoiled
T ₈	No	No	Slightly soft	No	Good
T ₉	No	Slightly	Slightly soft	No	Good

Plate.2.1 sensory evaluation



Plate.2.2 Storage studies



Fig.1 Moisture content of fresh cauliflower and cauliflower pickles

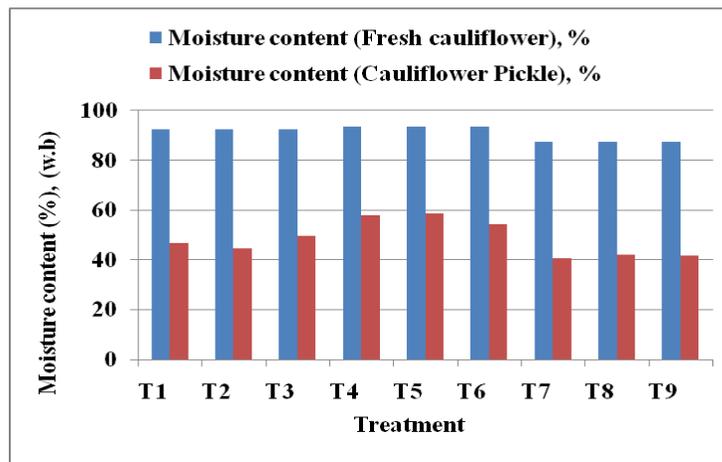


Fig.2 Protein content of cauliflower pickles

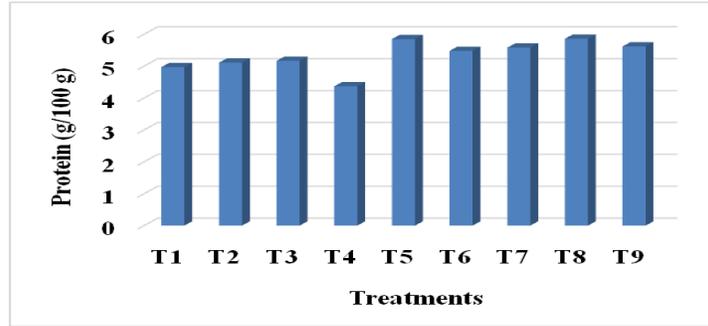


Fig.3 Vitamin C content of cauliflower Pickles

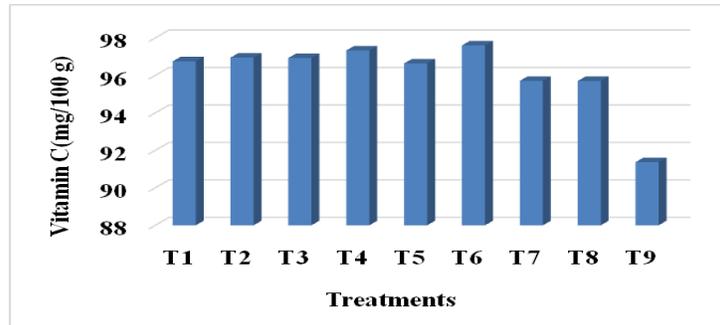


Fig.4 Ash content of cauliflower pickles

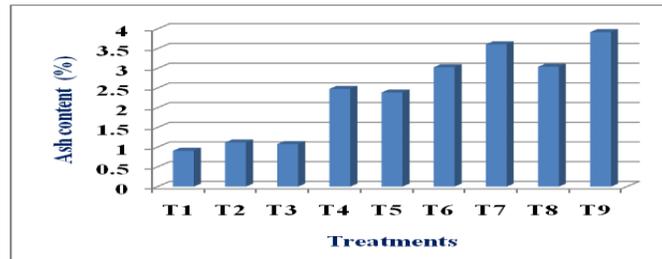


Fig.5 pH value of cauliflower pickles during storage periods

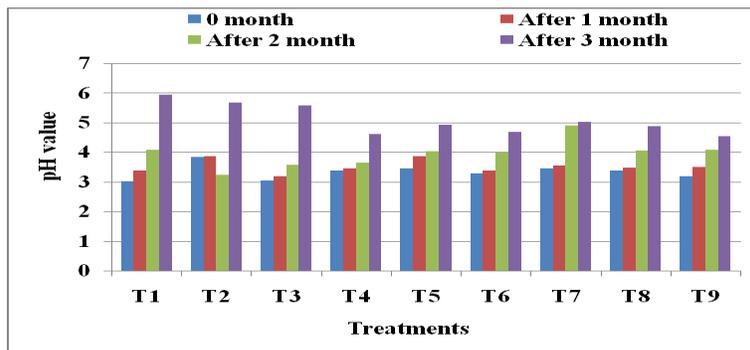
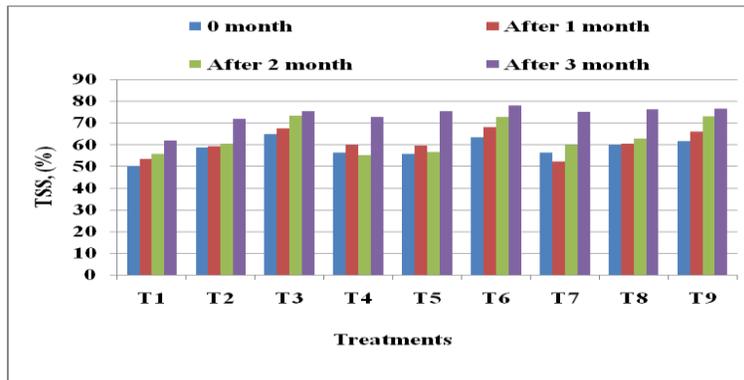


Fig.6 TSS of cauliflower pickles during storage periods



From Fig.4, it was found that the when we increased the spices ingredients in the fresh, boiled and fried pickles, then the ash content of pickles were found increased. In cauliflower pickles the maximum ash content was reported 3.92 % for treatment T₉ and minimum ash content was found 0.91 % for treatment T₁. The cause of increasing ash content may be the use of various types of spices in the treatments.

pH

The pH values of prepared pickles were determined by digital pH meter and average values of results were presented in Fig.5.

From Fig.5, it was reported that the three months of storage, a increasing trend of pH value with the increase duration of storage period was observed. Higher pH value 5.93 was reported significant for T₁ treatments for three months of storage periods whereas lower pH values 3.01 were observed significant for T₁ treatments for zero months of storage periods. The phenomenon might be possible due to oxidation of acid during storage resulting in higher pH values.

Total soluble solids (TSS)

Total soluble solids of prepared cauliflower pickles were determined by and hand

operated digital refractometer and average values of results were presented in Fig.6.

From Fig.6, it is highly variation was observed for TSS content between treatments during different storage month. The results exhibited that TSS content of cauliflower pickle developed in a continuous significantly higher with the expansion of storage period. The higher percentage of TSS during storage of cauliflower pickle was noted 78.00 % for treatment T₆ from third month after storage and lower TSS value was noted 50.10 % for treatment T₁ from zero month after storage. The TSS value of pickles were increased during storage period of time, it may be possible that the sugar and salt were mixed well and properly.

Sensory evaluation properties

The prepared cauliflower pickles of different treatments were presented to the panellists and asked to give score for appearance, aroma, texture, taste, colour and overall acceptability as per 9-point hedonic scale. The results of sensory evaluation of different treatments of cauliflower pickles for different storage periods were presented in Table 3 to 8 and discussed in the subsequent headings.

Table 3 to 8, shows the significant variation were observed for appearance, aroma, texture,

taste, colour and overall acceptability. It also shows the sensory values for all properties were more than 5.00 up to 2 months storage periods whereas after 3 months storage periods some values of sensory scores were found below 5.00 except T₁, T₄, T₅, T₇, and T₈.

Storage studies

Cauliflower pickles were prepared with different combinations of spices ingredients. Nine different treatments of cauliflower pickles were used for storage studies at room temperature (27°C to 33°C) up to 3 months at one month interval. The effect of storage period i.e. 0, 1, 2 and 3 months on colour change, off flavour, texture and visual fungal growth of the pickles were observed.

Storage studies of cauliflower pickles during storage period for 0 months

The effect of storage time during 0 months on colour change, off flavour and texture and visual fungal growth of the pickles were studied and shown in Table 9.

Table 3.1 shows that storage studies for 0 months period on colour change, off flavour, visual fungal growth of cauliflower pickle were are not change for all the treatments. And for the texture, the only treatment T₄ was found slightly soft while others treatment found firm. All the cauliflower pickle treatments were found good in good condition.

Storage studies of cauliflower pickles during storage period for 1 month

The effect of storage time during 1 month on colour change, off flavour and texture and visual fungal growth of the pickles were studied and shown in Table 10.

Table 10 shows that storage studies for the period of 1 month on colour changed, off flavour properties and visual fungal growth of cauliflower pickle were are not change for all the treatments, whereas for the texture, the treatment T₂, T₃, and T₄ were found slightly soft while others treatment found firm. All the cauliflower pickle treatments were found good in good condition.

Storage studies of cauliflower pickles during storage period for 2 months

The effect of storage time during 2 months on colour change, off flavour and texture and visual fungal growth of the pickles were studied and shown in Table 11.

Table 3.3 shows that storage studies for the period of 2 months on colour change properties were not change while off flavour properties and visual fungal growth of cauliflower pickles were changed for treatments T₄ and T₇ respectively. For the texture most of the treatments were found slightly soft and soft, except the treatment T₈ & T₉. All the cauliflower pickle treatments were found good only treatment T₇ was found slightly spoiled.

Storage studies of cauliflower pickles during storage period for 3 months

The effect of storage time during 3 months on colour change, off flavour and texture and visual fungal growth of the pickles were studied and shown in Table 12.

Table 3.4 shows that storage studies of cauliflower pickles for the period of 3 months, the colour change were observed for treatments T₃, T₄, T₅, T₇, whereas slightly off flavour properties were observed for treatments T₂, T₄, T₅, T₇ and T₉. The visual fungal growths of cauliflower pickle were reported for treatments T₃ and T₇ and for the

texture most of the treatments were found slightly soft and soft. All the cauliflower pickle treatments were found good condition except the treatments T₃ and T₇ which was found slightly spoiled.

In conclusion the physico-chemical properties like- moisture content, protein content, vitamin C, ash content, pH value, TSS value and sensory evaluation like- appearance, aroma, texture, taste, colour, overall acceptability and storage studied like- colour change, off flavour, texture, visual fungal growth of cauliflower pickle were studied. On the basis of overall studied we can say or recommend the treatment T₈ was found best followed by treatment T₉, T₆ and T₅. Thus we can say the cauliflower pickles prepared by frying in mustard oil or boiling in water and different composition of spices i.e. 250 gm cauliflower, 50 g of salt, 9 g ginger, 9 g red chili powder, 8 g cinnamon, 5 g cumin, 4 g cardamom, 11 g aniseed, 4 g clove, 16 g mustard, 40 g vinegar, 45 g sugar, 100 ml mustard oil, 12 g garlic were added and mix well.

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