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Studies on Effect of Different Frying Temperatures on Physico-Chemical Properties of Bitter Gourd Chips

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Abstract

Bitter gourd (***Momordica charantia Linn)*** also known as bitter melon is a vegetable that was optimise to preapre a chips. Bitter gourd slices were treated with 2% salt and 1% turmeric powder and allowed for 30 min. treated slice were dried in tray drier at 70^{0}C for 30 min and fried along with the corn flour at three different temperatures i.e 140^{0}C, 160^{0}C and 180^{0}C. The sample was named as T_1. The comparative studies between control sample T_0 and T_1 was conducted. The effect of frying temperature on physico-chemical properties of bitter gourd chips and sensory analysis was evaluated. Storage study was conducted after 10 days interval upto 40 days. During shelf life study it was observed that moisture content of control and treatment show slight increase or decrease from zero to 10 days but after 20, 30 and 40 days there was a increase in moisture content. Incorporation of corn increases the protein content as well as cripsiness of chips and salt and turmeric treatment reduces the bitterness. Marginal changes in prtein and ash during storage period. Fat content was decreased (17.19-15.85) during storage period. T_1 sample fried at 160^{0}C showed the best result among the others, which high scored in sensory evaluation. The product is recommended for children, youth and elderly persons to be used within 45 days.

Key Words – *Bitter gourd chips, corn flour, deep fat frying, salt and turmeric .*

1. Introduction

The most important attributes of fried food are texture, appearance and flavor. Chips are one of the most popular snacks in the United States and they have an oil content that ranges from 35.3% to 44.5% w.b. which gives the unique attributes combination that makes the chips desirable **(Garayo & Moreira, 2002).**

In recent years, there has been an increased interest in reducing the amount of oil content of foods because of health concerns considering that the consumption of high fat food is a major cause for obesity. In addition, the potential production of acrylamide during the process of frying at high temperatures has been considered as a reason to reduce the consumption of deep-fat fried products. As a consequence, there is a demand for healthier food and a need for a cooking method that offers the same desired organoleptic characteristics of deep-fat frying processes without elevating the levels of fat consumption while minimizing acrylamide formation.

It is well known that deep-fat frying is a prevalent and old food cooking method which can go back to 1600 BC. Although 160^{0}C is usually recommended for frying foods, it is always higher than 160^{0}C in the practical deep-fat frying (**Firestone, 1993**). Fast food processing, palatable taste of fried food and considerable economic benefit make the deep-fat frying become one of the most pop-ular food cooking methods used in household kitchen, fast-food restaurant and instant noodles industry. Furthermore, the sale of pre-cooked and ready-to-eat products which also refer to the deep-frying process has dramatically increased in the western world and is rapidly expanding throughout the developing countries. In other words, fried food has become an industry chain in catering industry. The fried food is endowed with attractive flavor, golden pellicle and crisp texture or mouth feel when it is fired under the appropriate conditions **(Rossell, 2001; Warner, 2008).**

Chips are the most popular variety of snacks on various occasions. Besides being salty, spicy or flavoured, consumer preference is always for fresh quality. Potato and banana chips are popular processed food items resulting in substantial value-addition. The main consumers of potato chips and wafers are families especially in urban and semiurban areas. Besides, hotels, restaurants, canteens, army establishments require potato chips in significant quantities. Chips are very popular amongst all age groups and they are made from various materials. Easy availability, freshness and competitive price are the main features. These products can be manufactured in any part of the country.

Bitter gourd (***Momordica charantia Linn***) also known as bitter melon is a vegetable that looks like a cucumber but with ugly gourd-like bumps all over it. Bitter gourds are commonly found in Asian countries and South America because it thrives in hot and humid climates. This vegetable tastes bitter as its name implies, it is used as ingredient in salads or vegetable dishes where it is believed to lower sugar content in the blood. Bitter gourds are very low in calories but dense with precious nutrients. It is an excellent source of vitamins B1, B2, and B3, C, magnesium, folic acid, zinc, phosphorus, manganese, and has high dietary fiber. Although the seeds, leaves, and vines of this vegetable have different uses, the fruit is the most predominantly used part of the plant in traditional herbal medicine.

Table.1 Experimental Design for process development of bitter gourd chips.

1.1 Variables/ Parameters	**1.2 Levels**	**1.3 Descriptions**	**Quality parameters**
1.4 Product	1.5 1	1.6 Bitter gourd Chips.	**A.Physico-chemical characteristics** Moisture content, fat, Protein estimation, Ash content, fiber **B.Sensory evaluation** 9 Point Hedonic scale **C.storage studies** Shelf life of final product.
1.7 Ingredients	1.8 6	1.9 Bitter gourd, salt, turmeric powder, Corn flour, Edible Oil, spices.	
1.10 Treatments Frying Temp	1.11 1 3	Salt and turmeric, corn flour 140°C, 160°C, 180°C	
1.12 Storage condition	1.13 1	1.14 Ambient temperature	
1.15 Packaging material	1.16 1	1.17 LDPE	
1.18 Sample Size	1.19 1	1.20 100 g	

2. Materials and Methods

The fully matured, freshly harvested Bitter gourd, salt, turmeric powder, Corn flour, Edible Oil, spices were procured from the local market of Allahabad. The equipment and machineries required in the present investigation were Tray dryer, Slicer, Electronic weighing balance, deep fat fryer, Stainless-steel pots, Soxhlet apparatus, Micro-Kjeldhal apparatus, Muffle furnace, Hot air oven, Hot Pan, Thermometer, Desiccators, Distillation chamber were utilized from the Department of Agricultural Process and Food Engineering, College Of Agricultural Engineering and Technology, Allahabad Agricultural Institute – Deemed University, Allahabad.

2.1 Recipe

Bitter guard slices	100 gm
Salt	2 gm
Turmeric powder	1 gm
Corn flour	10 gm
Soya oil	250 ml
Chat masala	5 gm

2.2Procedure:

The bitter gourd was selected by visual appearance of fresh and dark green colored, fully matured. It was not ripened n containing any physical damage on the surface. The bitter gourd were washed with clean water so as the remove the dirt, other disease causing organism or the adhering pesticides**.** Trim the ends off the bitter gourd. Slice them in half lengthways, remove the seeds and then slice them lengthways into long strips, 0.5cm (1/4-inch) wide. Cut the strips into lengths about 3.75cm (1/1/2 inches). Place the bitter melon pieces in a bowl, sprinkle liberally with 2% salt and 1%turmeric powder. Keep it for 30 min to reduce the bitterness of bitter gourd. The bitter gourd pieces were kept under running water and drain excess water from them. Bitter gourd slices were allowed to drying in the tray dryer at 70^0c for 30 min. After drying the corn flour was sprinkled on the chips and then fried into deep fat fryer at 140^0c, 160^0c and 180^0c for 3 min. After frying chips were removed and drained on the paper to reduce oil contain and then red chili powder and chat masala added for increasing polatability. Bitter gourd chips were packed into the LDPE bags and sealed with the help of sealing machine and well labeled. Packed bitter gourd chips were stored in the cool or dry place.

2.3Analysis of bitter gourd chips

2.3.1Physical analysis:

Bitter gourd chips were analyzed for diameter, thickness, Fracturability by following the respective procedures

(AACC, 2000)

Diameter (D): Six chips were placed horizontally (edge to edge) and rotated at 90° angle for reading measured by vernier caliper.

Thickness (T): biscuits thickness was measured with a vernier caliper in triplicate. Means were recorded. Six cookies were measured one-by-one.

Breakage Susceptibility: Breakage susceptibility of bitter gourd chips was evaluated using a tumbler technique **(Quintero-Fuentes et al. 1999).**

2.3.2Chemical analysis:

Moisture: Estimation of moisture hot air oven method at 105^0 c for hrs **(By AOAC, 1995).**

Fat: Extracting the sample in a Soxhlet apparatus for 6-8 h using petroleum ether. The solvent is evaporated and the residue is weighed **(By Ranganna, 1986).**

Protein: The estimation of nitrogen is done by kjeldahl method where in the protein content is obtained by multiplying the nitrogen value with 6.25 **(By Ranganna, 1986).**

Ash: By using muffle furnace method up to constant weigh. Ignite in a muffle furnace at 550+/- 25^0c for 4 hrs **(By Ranganna, 1986).**

2.3.3Sensory evaluation: Evaluate the products for acceptability based on its flavour, texture, appearance, amount of bitterness and overall acceptability using nine-point hedonic scale (1 = dislike extremely to 9 = like extremely; **Meilgaard et al., 1999**).

2.3.4Statistical analysis: Analyzed by two-way analysis of variance (ANOVA) and analysis is carried using Microsoft Excel (**By Gupta, 1997**).

3. Results and Discussion

3.1 Sensory Evaluation:

Sensory evaluation of bitter gourd chips during storage was done on the basis of sensory attributes. it was found that the treated chips sample fried at 160^0C had highest overall acceptability. Bitter gourd chips coontrol and treated sample were fried at thrre different temperatures 140^0C, 160^0C and 180^0C respectively. Sensory evaluation was done on 9- point hedonic scale. The evaluation of juice was done on the basis of color, taste, aroma, flavor, texture and overall acceptability. The value of different parameters was written on average score and shown below in tabular form and its chart was also prepared where T0 was control and T1 was treated sample fried at 3 different temperatures (140^0C, 160^0C and 180^0C). Sensory analysis of bitter gourd chips of samples T_0 and $T_{1,}$ was carried out on the basis of Colour, Taste, Aroma, Flavour, Texture, Appearance and Overall acceptability with the help of sensory evaluator on 9 point hedonic scale it was calculated. Sample T_1 fried at 160^0C was more acceptable as compare to other samples.

3.2Physico-chemical Analysis :

3.2.1Effect of frying temperature on Diameter of bitter gourd chips

During the frying of bitter gourd chips a significantly effect was observed it was judge on the basis of diameter, thickness, Fracturability. The diameter of chips was change after frying it was not constant for all treatment samples. The diameter of fried chips for control sample (T_0) and (T_1) was change lightly during frying at temperature 160°C for 3 min. But the remaining sample was changes in their diameter on different temperatures any effect were observed. Sample T_0 and T_1 there was an effect observed after frying at temperature120^0C and 180^0C. This change and effect of frying temperature are shown **fig. 2**.

3.2.2Effect of frying temperature on thickness of bitter gourd chips

There were no significant differences among control (T_0) and (T_1). (**Fig 3)** shows sample T_1 fried at 180^0C was the least thick of all treatments. Because of frying was the most significant factor for the difference between T_0 and T_1, this difference is not due to the amount of corn flour that was added to chips. It is important to mention that bitter gourd chips were fried for different temperatures at same time. 1.5mm thicker slice of bitter gourd chips in both treatments were fried at 140^0C, 160^0c and 180^0C respectively. Control sample (T_0) has 1.4, 1.3 and 1.2mm and treated sample (T_1) has 1.5, 1.4.5 1.3mm thickness at 140^0C, 160^0c and 180^0C respectively .

3.2.3Effect of frying temperature on texture of bitter gourd chips

Fracturability test:

Figure 4 shows the comparison of force between T_0 and T_1 fried bitter gourd samples. Overall, lower temperature bitter gourd chip had higher force and work than high temperature fried bitter gourd chips. These results were expected since in high temperature fried bitter gourd chips were thicker than fried in low temperature. The thicker the bitter gourd chip, the more force and work it will take to break it. Differences in texture were mainly caused by frying more so than the corn flour fortification. The first peak force indicates the maximum breaking force of the sample. The series of minor fractures that appear after the initial fracture indicate that the chip sample was composed of various layers.

3.2.4Effects of frying temperature on percent moisture content of bitter gourd chips

The percent of moisture content decreases with increase in frying temperature. Lower frying temperature have higher amount of moisture content. The percent moisture score for T_0 was 1.8, 1.6 and 1.4 percent and sample T_1 was 2.8, 1.85, 1.45 percent respectively fried at 140^{0}C, 160^{0}C and 180^{0}C. The difference between percent of moisture content was observed due to different in frying temperature.

The final moisture content in the fried chip must be less than 2% to ensure a crisp texture (**McDonough et al 2001**). Higher moisture contents result in tough, chewy texture.

3.2.5Effects of frying temperature on percent fat content of bitter gourd chips

The percent of fat content increases with increase in frying temperature. Higher frying temperature have higher amount of fat content. The percent fat score for T_0 was 16.57 percent, 16.70 percent, 17.12 percent and for T_1 was 17.02 percent, 17.19 percent and 17.89 percent fried in temperature at 140^{0}C, 160^{0}c and 180^{0}C respectively. The difference between percent of fat content was observed due to different in frying temperature. The amount of moisture present in the chips was replaced by the oil and replacing rate is depending upon the temperature of the oil hence the amount of fat content increases with increase in temperature. High frying temperature rapidly replaces moisture into fat and due to this the fat content is inversely proportional to the frying temperature.

3.2.6Effects of frying temperature on percent protein content of bitter gourd chips

The percent of protein content was significantly affected by the frying temperature. Protein is highly heat sensible compound it goes under denaturation when comes in contact with the heat. Higher frying temperature resulted lower amount of protein content. The percent protein score for T_0 was 0.89 percent, 0.84 percent, 0.69 percent and for T_1 was 2.79 percent, 2.26 percent and 1.58 percent fried in temperature at 140^{0}C, 160^{0}c and 180^{0}C respectively. The difference between percent of protein content was observed due to different in frying temperature. Corn flour was used for treated samples, corn flour is rich source of protein hence the protein content of the control sample is slightly lower than the treated samples.

3.2.7Effects of frying temperature on percent ash content of bitter gourd chips

The percent of ash content was not affected by the frying temperature. After complete burning of organic material the residue remains was known as Ash. The percent ash score for T_0 was 2.27 percent, 2.30 percent and 2.51 and for T1 was 2.67 percent, 2.86 percent and 2.89 percent fried in temperature at 140^{0}C, 160^{0}c and 180^{0}C respectively. Corn flour was used for treated samples, corn flour is rich source of protein, carbohydrates, minerals and other nutritional compounds hence the ash content of the control sample (T_0) is slightly lower than the treated samples (T_1).

Table 1 Sensory analysis of bitter gourd chips

ORGANOLEPTIC SCORE								
Sample	**Frying temp. (^{0}C)**	**Color**	**Taste**	**Aroma**	**Flavour**	**Texture**	**Appearance**	**Overall Acceptability**
T_o	140	7	3.5	4	3.5	5	6	4.83
	160	6	4	4	4	7	5	5
	180	5	4.5	4.5	4	6	6	5
T_1	140	7	6	6.5	6	6	6	6.25
	160	8	8	8.5	8	7	8	7.91
	180	7	7	7.5	7	8	7	7.25
F- test		NS	S	S	S	NS	NS	S
S. Ed. (±)		0.667	0.645	0.601	0.624	0.816	0.667	0.486
C. D. (P = 0.05)		1.420	1.375	1.280	1.328	1.739	1.420	1.035

Table 2 Effect of frying temperature on diameter of bitter gourd chips

Temperature ^{0}C	140	160	180
T_0	2.8	2.7	2.6
T_1	2.9	2.8	2.6
	Result	S. Ed. (±)	C.D. at 5%
Due to days	**S**	0.033	0.071
Due to temperature	**NS**	0.041	0.087

Table 3 Effect of frying temperature on thickness of bitter gourd chips

Temperature ^{0}C	140	160	180
T_0	1.4	1.3	1.2
T_1	1.5	1.45	1.3
	Result	S. Ed. (±)	C.D. at 5%
Due to days	**S**	0.017	0.035
Due to temperature	**S**	0.020	0.043

Table.No.4 Force comparison of fried bitter gourd chips

Temperature ^{0}C	140	160	180
T_0	20	18	15
T_1	17	15	13
	Result	S. Ed. (±)	C.D. at 5%
Due to days	**S**	0.333	0.707
Due to temperature	**S**	0.408	0.865

Table 5 Effect of frying temperatures on percent moisture content of bitter gourd chips

Temperature ^{0}C	140	160	180
T_0	1.8	1.6	1..4
T_1	2.5	1.8	1.6
	Result	S. Ed. (±)	C.D. at 5%
Due to days	**NS**	0.167	0.353
Due to temperature	**NS**	0.204	0.433

Table 6 Effect of frying temperature on percent fat content of bitter gourd chips

Temperature ^{0}C	140	160	180
T_0	16.57	16.70	17.12
T_1	17.02	17.19	17.89
	Result	S. Ed. (±)	C.D. at 5%
Due to days	**NS**	0.101	0.213
Due to temperature	**S**	0.123	0.261

Table 7 Effect of frying temperature on percent protein content of bitter gourd chips

Temperature ^{0}C	140	160	180
T_0	0.89	0.84	0.69
T_1	2.79	2.26	1.58
	Result	S. Ed. (±)	C.D. at 5%
Due to days	**NS**	0.292	0.618
Due to temperature	**S**	0.357	0.757

Table 8 Effect of frying temperature on percent Ash content of bitter gourd chips

Temperature ^{0}C	140	160	180
T_0	2.27	2.30	2.51
T_1	2.67	2.86	2.89
	Result	S. Ed. (±)	C.D. at 5%
Due to days	**NS**	0.057	0.121
Due to temperature	**S**	0.070	0.148

Table 9 Effect of storage day on percent moisture content of bitter gourd chips

No. of Treatment	**Temperature (^{0}C)**	**Storage days**				
		0 Day	**10 Day**	**20 Day**	**30 Day**	**40 Day**
T_0	**140**	1.8	1.87	1.99	2.15	2.58
	160	1.6	1.82	1.94	2.07	2.19
	180	1.4	1.78	1.84	1.94	1.98
T_1	**140**	2.5	2.63	2.81	2.93	3.29
	160	1.8	1.89	1.94	1.98	2.13
	180	1.6	1.69	1.75	1.96	2.05
		F. Tab. 5%	**Result**	S. Ed. (±)		
Due to treatment		**S**	0.044	0.088		
Due to days		**S**	0.102	0.202		
Due to temperature		**S**	0.044	0.088		

Table 10 Effects of storage day on percent Fat content of bitter gourd chips

No. of Treatment	Temperature (^{0}C)	Storage days				
		0 Day	10 Day	20 Day	30 Day	40 Day
T_0	140	16.57	16.17	15.94	15.15	14.58
	160	16.70	16.52	16.04	15.77	14.89
	180	17.12	17.02	16.84	16.14	14.98
T_1	140	17.02	16.63	16.03	15.52	14.29
	160	17.19	17.05	16.81	16.02	15.85
	180	17.89	17.52	17.26	16.96	15.52
		F. Tab. 5%	Result	S. Ed. (±)		
Due to treatment		S	0.048	0.095		
Due to days		S	0.111	0.220		
Due to temperature		S	0.048	0.095		

Table 11 Effect of storage day on percent protein content of bitter gourd chips

No. of Treatment	Temperature (^{0}C)	Stora				
		0 Day	10 Day	20 Day	30 Day	40 Day
T_0	140	2.9	2.85	2.77	2.67	2.46
	160	2.7	2.68	2.63	2.59	2.43
	180	1.8	1.75	1.58	1.34	1.29
T_1	140	3.5	3.48	3.45	3.41	3.39
	160	3.2	3.18	3.15	3.11	3.03
	180	2.6	2.57	2.54	2.51	2.47
		F. Tab. 5%	Result	S. Ed. (±)		
Due to treatment		S	0.027	0.053		
Due to days		S	0.061	0.122		
Due to temperature		S	0.027	0.053		

Table 12 Effect of storage day on percent Ash content of bitter gourd chips

No. of Treatment	Temperature (^{0}C)	Storage days				
		0 Day	10 Day	20 Day	30 Day	40 Day
T_0	140	2.15	2.17	2.19	2.27	2.46
	160	2.27	2.30	2.34	2.35	2.38
	180	2..07	2.1	2.18	2.24	2.29
T_1	140	2.67	2.69	2.73	2.75	2.78
	160	2.76	2.78	2.81	2.83	2.90
	180	2.58	2.59	2.63	2.67	2.71
		F. Tab. 5%	Result	S. Ed. (±)		
Due to treatment		S	0.007	0.014		
Due to days		S	0.017	0.033		
Due to temperature		S	0.007	0.014		

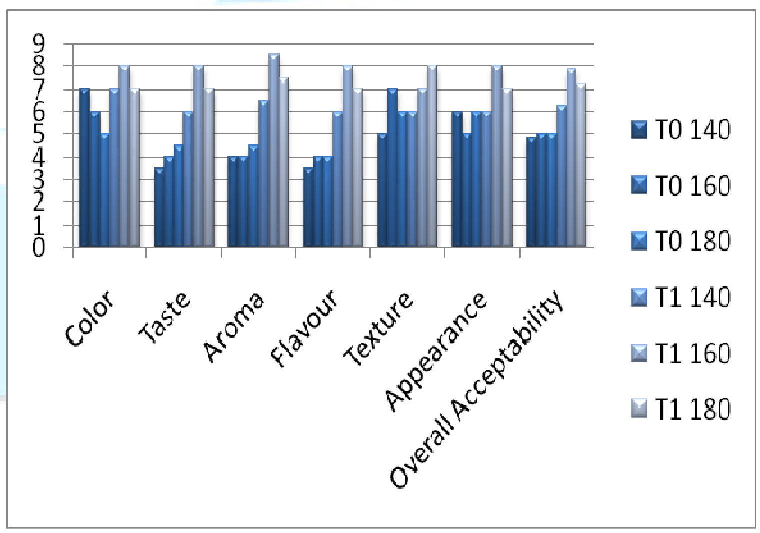

Fig 1 Sensory analysis of bitter gourd chips

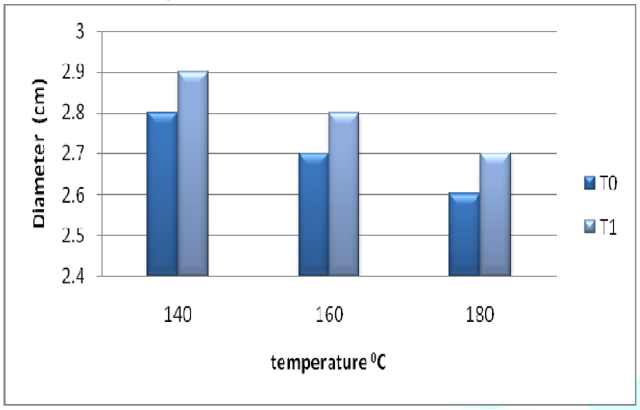

Fig. 2 Effect of frying temperature on Diameter of bitter gourd chips

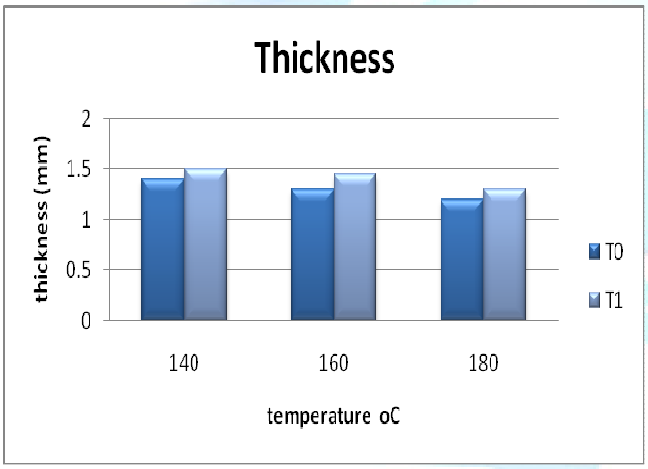

Fig 3 Effect of frying temperature on thickness of bitter gourd chips

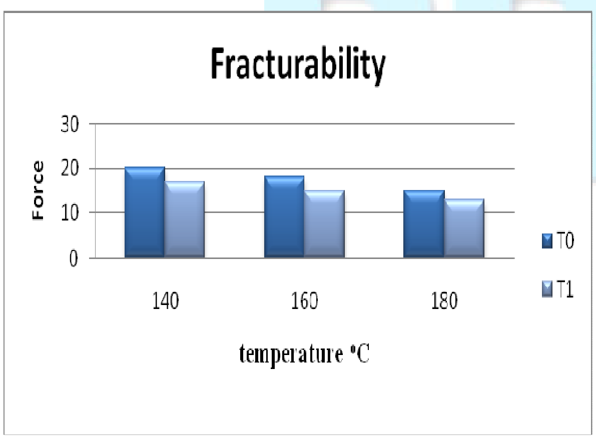

Fig 4 Force comparison of fried bitter gourd chips

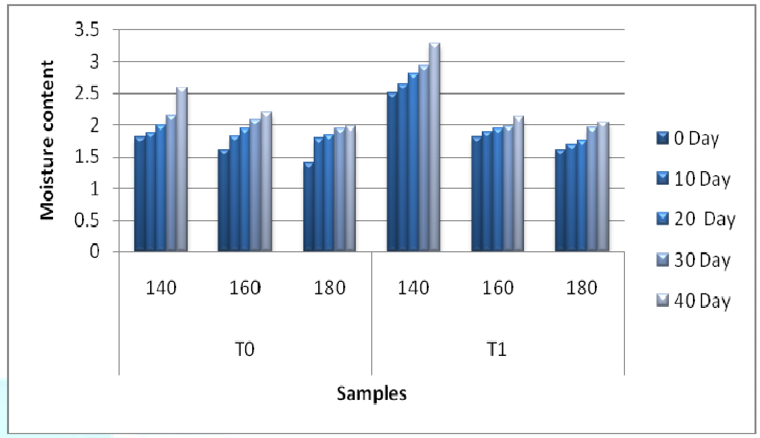

Fig 2 Effect of storage day on percent moisture content of bitter gourd chips

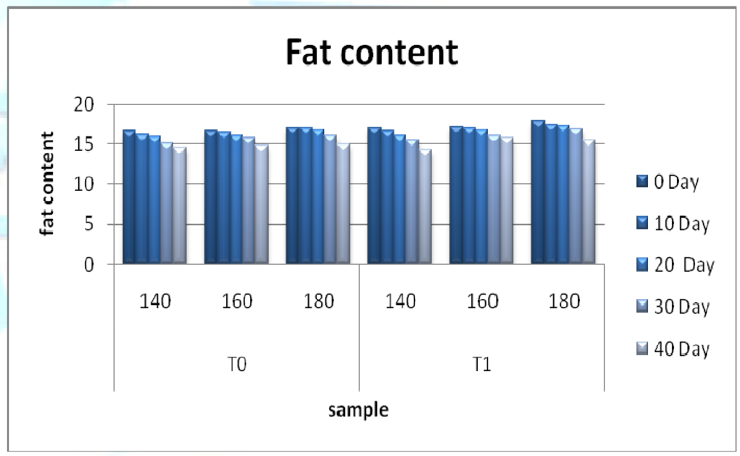

Fig 3 Effects of storage day on percent Fat content of bitter gourd chips

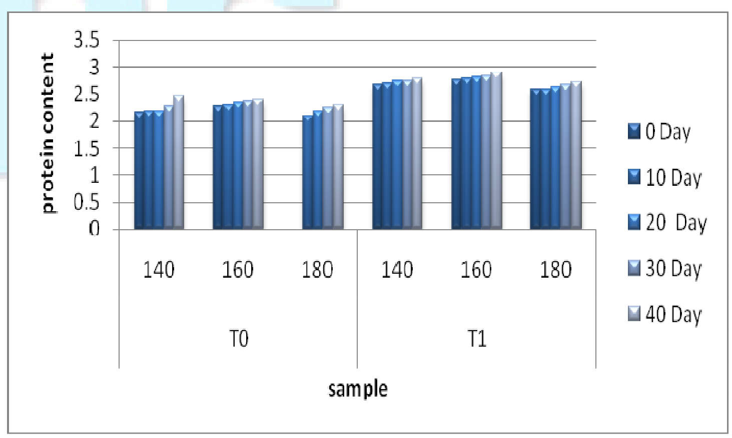

Fig 4 Effect of storage days on percent protein content of bitter gourd chips

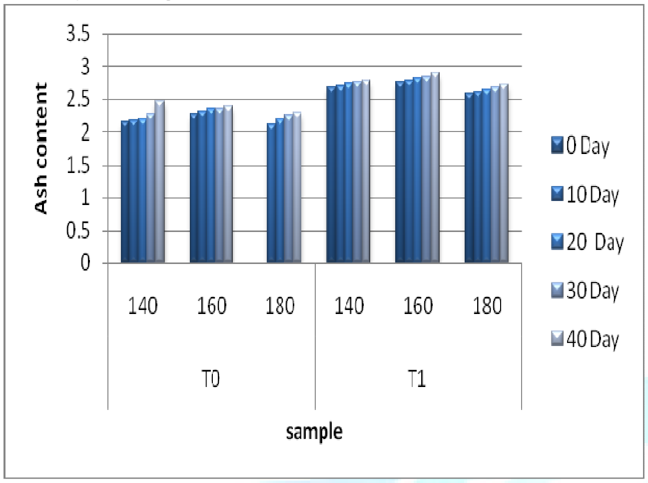

Fig 5 Effect of storage days on percent protein content of bitter gourd chips

Conclusion

Among the studies were conducted for entitled "Studies on Effect of Different Frying Temperature on Bitter Gourd Chips". To reduce the bitter taste of bitter gourd chips the slice of bitter gourd were treated with 2% salt and 1% turmeric and then allowed for 30 min. control sample (T_0) and treated sample (T_1) were fried in three different temperatures for 3 min i.e (140^{0}C, 160^{0}C and 180^{0}C) corn flour was used in treated samples along with frying. The effects of temperature on physico-chemical properties of bitter gourd were analyzed. The incorporation of corn flour increases the nutritional quality of bitter gourd chips as well as crispiness of chips. The T_1 sample fried at 160^{0}C found satisfactory after testing of physico-chemical and depending upon different sensory attributes like color, flavor, taste, texture, at over all acceptability. There was a significant difference in these treatment samples but the T_1 sample found more satisfactory as compare other samples. Bitter gourd was neglected due to its bitter taste but treatments reduced bitterness from bitter gourd hence the utilization of bitter gourd was capitalized.

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Appendix

ANOVA 1 Effect of frying temperature on diameter

ANOVA :

Source	d. f.	S.S.	M.S.S.	F. Cal.	F. Tab. 5%	Result
Due to days	2	0.063	0.032	19	19.00	**S**
Due to temperature	1	0.007	0.007	4	18.51	**NS**
Error	2	0.003	0.002	-	-	-
TOTAL	5		-	-	-	-

ANOVA 2 Effect of frying temperature on thickness of bitter gourd chips

Table 4.3.1 Effect of frying temperatures on percent moisture content of bitter gourd chips

ANOVA :

Source	d. f.	S.S.	M.S.S.	F. Cal.	F. Tab. 5%	Result
Due to days	2	0.041	0.020	49	19.00	**S**
Due to temperature	1	0.020	0.020	49	18.51	**S**
Error	2	0.001	0.000	-	-	-
TOTAL	5		-	-	-	-

ANOVA :

Source	d.f.	S.S.	M.S.S.	F. Cal.	F. Tab. 5%	**Result**
Due to days	2	0.443	0.222	5.32	19.00	**NS**
Due to temperature	1	0.202	0.202	4.84	18.51	**NS**
Error	2	0.083	0.042	-	-	-
TOTAL	5		-	-	-	-

Table 4.3.2 Effect of frying temperature on percent fat content of bitter gourd chips

ANOVA :

Source	d.f.	S.S.	M.S.S.	F. Cal.	F. Tab. 5%	**Result**
Due to days	2	0.560	0.280	18.42543 9	19.00	**NS**
Due to temperature	1	0.487	0.487	32.0625	18.51	**S**
Error	2	0.030	0.015	-	-	-
TOTAL	5		-	-	-	-

Table 4.3.3 Effect of frying temperature on percent protein content of bitter gourd chips

ANOVA :

Source	d.f.	S.S.	M.S.S.	F. Cal.	F. Tab. 5%	**Result**
Due to days	2	0.502	0.251	1.96 7741 9	19.00	**NS**
Due to temperature	1	2.954	2.954	23.1 4757 7	18.51	**S**
Error	2	0.255	0.128	-	-	-
TOTAL	5		-	-	-	-

Table 4.3.4 Effect of frying temperature on percent Ash content of bitter gourd chips

ANOVA :

Source	d.f.	S.S.	M.S.S.	F. Cal.	F. Tab. 5%	**Result**
Due to days	2	0.053	0.026	5.438356 2	19.00	**NS**
Due to temperature	1	0.299	0.299	61.49315 1	18.51	**S**
Error	2	0.010	0.005	-	-	-
TOTAL	5		-	-	-	-

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