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Comparative Study of Frying to Different Slice Thickness of Potato: Effect on Nutritive Value

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HIGHLIGHTS

- The slices of different thickness in experiment is 0.2mm, 0.3mm, 0.4mm and 0.5mm using electric and wooden slicer.
- The suitability of temperature for acceptance of chip colour is best at 170 C and 180 °C except at 190 °C.
- Reduction of oil absorption is maximum of slice thickness of 0.5mm.
- After processing, reducing sugars content is reduced by 77.9 % and 81.1 % at 180°C with 0.2mm thickness in variety Kufri Chipsona-1 and Kufri Chipsona-3.
- Processed chips retained more phenols than raw potato.

Abstract: Nutritional composition, of potato was evaluated to establish frying processing conditions to estimate the sensory profile and acceptability of different slice thickness.The slice thickness were set to 0.2, 0.3, 0.4 and 0.5mm. The variables studied were: time, temperature and potato varieties. The comparisons evaluated were: chip colour, frying time, effect of different slice thickness, oil absorption to different thickness, content of reducing sugars, sucrose and phenols after frying of slices. Potato chips are sold in organized sectors and un-organised sectors sale chips through street vendors all over the India. Perception or profiling of chips of different thickness data and their sensory evaluation part has not been done so far. Two processing varieties, Kufri Chipsona-1 and Kufri Chipsona-3 (110 maturity days) were analysed for different thickness regulating different temperature of 170, 180 and 190°C. Associated parameters reducing sugars, sucrose and phenols were analysed before and after frying.The temperature of 170 and 180 °C was found to be suitable temperature for acceptable chip colour quality. Slice thickness of 0.5mm reduced the oil absorption. Reduction in reducing sugars was found to be maximum (77.9 %) in variety Kufri Chipsona-1, at 180°C with 0.2mm thickness followed by at 170°C with the same thickness (77.0%) in variety Kufri Chipsona-1. Phenol content in processed chips, markedly was more than raw potato phenol values. Sensory evaluation results in overall acceptance of 0.2mm thick slices than 0.3, 0.4 and 0.5mm thick slices.

Keywords: biochemical parameters; oil absorption; potato;slice thickness; temperature.

INTRODUCTION

Potato (*Solanum Tuberosum* L.) is one of the most important vegetable crop and is used daily as almost by all the world people. In European countries potato is consumed as a staple diet both as processed and in fresh form. In most of the countries, it is used as the basic food due to its high efficiency, abundant nutrient present and possibility of growing potato in diverse conditions. Utilization of potato either as raw material, boiled or fried is increasing nowadays in Asian countries [1]. Among fried category, chips are the most popular potato product and is liked by almost all different age group people. In food processing industries, deep fat frying is wide-spread operation that make the potato chips tasty and crispy. Potatoes are being processed at small scale in rural India.Potato processing in the unorganized sector is of considerable importance in a country like majority of the population afford to purchase potato chips produced by un-organized sector than the organized sector which is much more costlier. In India approximately 377 thousand tonnes of potato chips are prepared by unorganized sector. Potato processors, in small towns are found in almost all cities and towns in the country and they produce products like potato chips [2]. Deep fat frying of potato is widely used both at home and industrial preparation [3] and is based on principle of heat transfer from hot oil which removes moisture from potato chips and oil uptake by that particular object [4]. Generally two types of fryers are found: smaller capacity batch fryers used by the restaurant/catering/fast food outlets and the larger continuous fryers that are used on the industrial scale to produce large volume of frying products. Small scale fryers have capacity ranging from 5 to 25 liters, whereas, the industrial continuous fryer size may range from 100 to 4000 kg products per hour [5]. After frying potato chips has unique combination of texture and flavor and are very much desirable in market. Crispness and texture of the products are dependent upon variety, slice thickness, oil used, temperature and duration of frying. During frying operations, desirable and appeal characteristics of products are due to formation of complex structure [6]. During frying mechanism, moisture content changes from approximately 80% in the raw potato to below 2% in the final product during 2-4 minutes cooking time [7]. The crispy texture of potato chips is one of the most important quality indicators of the finished product apart from colour, odour and flavor and chips texture is described in terms of crispiness, hardness and crunchiness. The frying of potato slices is mainly influenced by the thickness of the slices, the temperature of the oil and the dry matter content of the potato. Various studies indicated that the most of oils remains confined to the surface region of fried potato [8] and there are evidences that are based on the fact that oil almost penetrates into the structure after it is removed from the frying media and during the cooling process period [9]. Pore size distribution is important for the absorption of oil captured by chips, the smaller the holes in the chips, the more air will be trapped during frying [10]. The texture of fried food not only depends on raw material such as dry matter content, size of starch granules and the processing condition but also dependent on the variety and maturity of the crop.

Approximately more than 85% of the potato production occurs in Uttar Pradesh. Uttar Pradesh is the largest producer of potato in India, accounting for more than 32 per cent of the country's total potato production. In the year 2019-2020, the National Horticulture Board (NHB) had recorded potato production in Uttar Pradesh at 140.49 lakh tones. Potato products like chips are sold in every corner of the state. Organized and un-organised sectors meets the requirements of people by local markets. Meagre information is available on effect of slice thickness, oil absorption and varying temperature on Indigenous varieties chips sale by the unorganized sectors. Keeping in view this work aimed at determining the influence of various thickness of potato chips, physico-chemical properties (oil absorption and colour) of fried chips, effect of after frying on biochemical constituents (reducing sugars, sucrose and phenols) and then the optimal frying conditions were chosen after sensory evaluation.

MATERIAL AND METHODS

Sampling

Two processing varieties, Kufri Chipsona-1 and Kufri Chipsona-3 at full crop maturity (110 days) were graded from fields of ICAR-Central Potato Research Institute Campus, Modipuram, Meerut (geographic coordinates:29.1^{o}N latitude, 77.92 ^{o} E longitude, and an altitude of 300 m above mean sea level). Recommended dose for processing potato was 270:80:150 NPK kg per hectare. Round shape, devoid of green colour, uniform potato tubers (50 numbers) of processable size with a diameter of 45-85 mm were selected. The raw material was thoroughly cleansed before sampling to eliminate any adherent soil or dust from the surface of the potato. Tubers were washed and air dried, with excess water removed with a paper towel.

Material

Iso-propanol, Folin-Ciocalteu phenol, sodium carbonate, potassium hydroxide, anthrone and petroleum ether were purchased from Sisco research laboratories, Meerut, India.

Sampling of biochemical constituents

Fresh potato tubers were peeled. After peeling, one centimeter thick slice was cut longitudinally from the stem to the bud end of the potato tuber, parallel to the tuber's centre. The slice is then cut into three equal-length segments longitudinally. These pieces were coarsely chopped and pooled separately (in triplicate) for extraction and measurement of biochemical parameters such as reducing sugars, sucrose and phenols. Reducing sugars, sucrose and phenols were determined in fresh (raw tuber) and after frying of potato slices. The biochemical components after frying was determined using crushed potato chips.

Sample extraction

Finely chopped (10g), randomized samples after proper mixing was refluxed using 80% iso-propanol for 6-8 hours. After extraction, sample was filtered and volume was made to 100mL using distilled water. The extract was stored in freeze for estimation of biochemical parameters viz., reducing sugars, sucrose and phenols. Sample of crushed chips (10 g) was taken in flask and extraction was done in 80% isopropanol.

Analysis

Reducing sugars

Ethanolic extract (0.2mL) was then heated with alkaline copper tartrate (1mL) to reduce the copper from cupric to cuprous state resulting in formation of cuprous oxide. Before estimation of reducing sugars, interfering compounds like soluble proteins were removed by precipitating using saturated lead acetate solution followed by centrifuging. Extract was boiled in test-tubes for 20 minutes using water-bath. The content was cooled to room-temperature. 1mL of arsenomolybdate reagent was added optical density of the solution was measured spectrophotometerically (OR-5100, UV-visible spectrophotometer at 620 nm [11].

Phenols

Ethanolic extract (80%) was centrifuged at 10000rpm for 20minutes. Supernatant was collected and re-extracted again with 80% ethanol and evaporated to dryness, volume was made using distilled water up to 80mL. To (100-2.0µL) aliquot, addition of 0.5mLFolin-Ciocalteu phenol reagent was followed by vortex mixing and volume was raised to 10 mL with distilled water. After incubation for 3minutes 35 % (1ml) sodium carbonate was added. Test-tubes were was boiled for one minute only and vortex mixed, and the content was cooled and absorbance was read at 630nm [12].

Sucrose

Sucrose was evaluated by the standardised method as mentioned previously [13]. Ethanolic extract was filtered using what man no.1. Concentrated extract was again re-extracted in 50mL of 80% iso-propanol for one hour and filtered. Alcohol was evaporated on hot plate (70^{o}C) till 10-15mL residues left. Volume was made to 80 mL. To the 0.2 mL of extract, 0.8 mL of distilled water was added and volume was made to 1mL. Potassium hydroxide (30%, 0.1mL) was added and tubes were kept in boiling water bath for 10 min. 3mL of anthrone was added to each test tube. Solution was incubated in water bath for 15min at 40ºC and absorbance was read at 620nm.

Potato chips

Chips were prepared by the procedure in accordance with standardized method [14]. Potatoes were peeled with peeler and washed. The slices of different thickness were done to get four different thicknesses viz., 0.2mm, 0.3mm, 0.4mm and 0.5mm using electric slicer (Figure 1a), wooden slicer (Figure 1b) changing different guage screws, respectively. Cutting, peeling or slicing of potato tubers disrupts the cellular membranes. In response the enzyme polyphenol oxidase (PPO) within the plastids come in contact with phenolic compounds that are present in vacuole. Series of reactions get initiated that lead to quinines that results in enzymatic discoloration. To avoid enzymic discoloration, potato slices were washed. After cooking darkening in potato happens on oxidation with air after cooking including, boiling, frying and baking. The thickness of slices were measured with digital (Figure 1c) Vernier calliper (Model carbon fiber composites digital caliper with resolution 0.1mm/0.01”, accuracy 0.2mm/ 0.01” and battery SR44/LR44 1.5V). Slices were rinsed separately to remove any extra starch from the surface. The slices were spread out and allowed to dry. After drying, the samples were fried until bubbling stopped in a deep fat fryer that is thermostatically regulated at the frying oil temperatures. A thermostat kind deep fat fryer was used. The oil was heated to a starting temperature at 170°C. The heated oil was used to evaporate the moisture from the potato slices. The quantity of the oil was adjusted so that the samples of different water content should completely dehydrate. A set of 10 samples of potato slices of different thickness were readied as per the protocol, the oil was heated to 170,180 and 190 °C. The time required to complete the dehydration process for each different slice thickness at different temperature range was observed carefully and recorded. After frying of chips they were allowed to cool and were kept sealed in polypropylene bags.

The temperatures were adjusted (170, 180 and 190 °C) as per need of the frying. Media used for frying of chips was refined soy bean oil. Samples were taken out of the deep fat fryer and allowed to cool. Chips were packaged in aluminium pouches and stored for future analysis after cooling. Chip colour was subjectively assessed by visual scoring of the colour on the scale of 1 to 10, where 1 denoted highly acceptable and scored up to 3 was considerable acceptable and chip colour of 10 denoted black/brown colour.

Different slicers

Figure a. Electric slicer

Figure b. Wooden slicer

Figure c. Measurement with vernier calliper

Figure 1. (a) Electric slicer; (b) Wooden slicer. (c) Measurement of slice thickness with vernier caliper.

Cooking end point

The end point of cooking depends basically on the degree of food: that is generally characterized by sensory quality parameters like colour, odour, texture and shape. Whereas for the cooking end point or cooking time, two things are important.

-Formation of typical surface browning of the product, attractive and flavor/aroma.

-Observation of inner cooking degree visible by colour, taste and texture of the product.

Oil extraction

Oil content was determined by the standardized method [15]. After frying and cooling the to room temperature, samples were dipped immediately in beaker contacting 100mL of petroleum ether for 3 seconds to remove the adhered oil to the surface. After crushing the samples, the net oil absorbed by the samples was estimated by soxhlet extraction. Left over oil content of samples was determined in hot air oven at 70-75 °C for 12 hours until the sample weight was constant.

Determination of sensory evaluation

Color, taste, texture and overall acceptability of processed potato chips were evaluated by 10 panelists. The panelists scored for flavor, oiliness, crispiness and overall acceptability according to the standard headonic scale from 5 (like extremely) to 1(dislike extremely) using standard method [16].

Where, Bad =1, Fair =2, Good =3, Very Good =4, Excellent =5

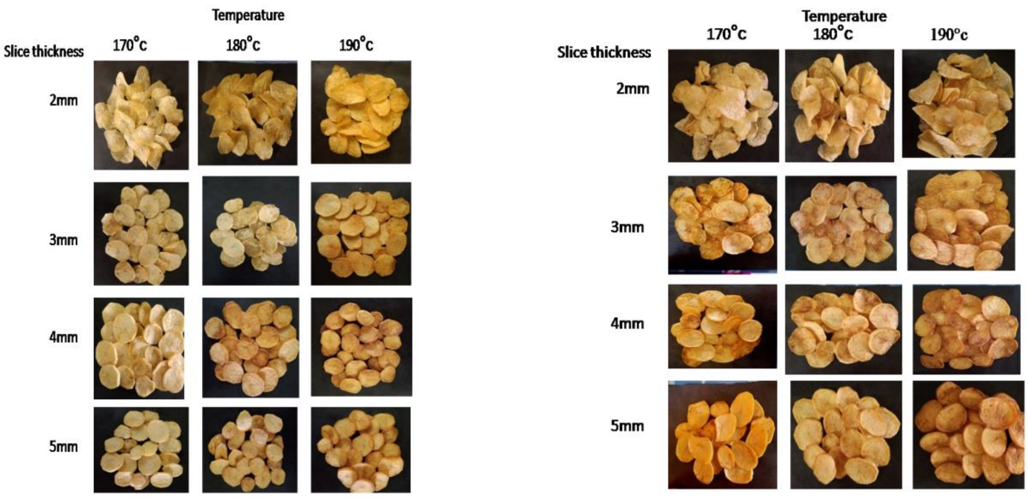
Statistical analysis

All experiments were carried out utilizing a completely randomised block design. The experimental data were subjected to analysis of variance at the CROPSTAT. Confidence level of 0.05, by the use of software. At p 0.05, the difference was declared statistically significant.

RESULTS

The chip colour of variety Kufri Chipsona-1 were found to be acceptable on the scale of 1 to 10 at 0.2, 0.3 and 0.4mm of slice thickness. The suitability of temperature for acceptable chip colour quality was at 170 and 180°C the same variety indicated different chip colour when subjected to increase in temperature by 10 degree i.e. 190 °C (Table 1, Figure 2a). Acceptable chip colour (2.8) was found with the slice thickness of 0.2mm. Chip colour score ranged from 1.0 to 3.0 and final time for cooking ranged with minimum time of 3.0 minutes to maximum up to 16.0 minutes. At 190 °C, frying varied between 6.0 to 12.0 minutes however, results of chip colour were not found acceptable. In variety Kufri Chipsona-3 acceptable chip colour score was found only with 0.2mm thickness of slice at frying temperature of 170, 180 and 190 °C (Figure 2b). Increase in slice thickness from 0.3 to 0.5mm, in Kufri Chipsona-3 were found to double the chip colour score as reported for the variety Kufri Chipsona-1. The time taken for frying by the chips increased as the thickness of the slice was increased in both the varieties.

The results reported in Table 1 indicates that as the frying temperature was lowered the time required to complete the dehydration process was increased markedly. For the slice thickness of 0.2mm the time required for frying samples was 4.0 minutes. Increasing slice thickness to 0.3mm the time utilized was increased to 8 minutes. When the slice thickness was increased to 0.4mm the time noted for frying was 14.0 minutes. Likewise increasing thickness to 0.5mm, the time increased to 16.0 minutes. There was significant ($p>0.05$) variation in frying time and temperature among two varieties that were evaluated. Interaction between variety and temperature, variety and thickness, thickness and temperature was found to be significant ($p>0.05$).



(a) (b)

Figure 2. (a) Chip colour of variety Kufri Chipsona-1; (b) chip colour of variety Kufri Chipsona-3

The oil content of the chips increased from 13.8% for the chips sliced 0.5 mm to 29.7% for the chips sliced at 0.2mm thickness. Highest temperature of 190°C produced oil content of 17.7%. The lowest temperature of 170°C produced mean content of 29.7%. Each mean % oil value for each frying temperature was significant different at 0.05 level. Lowest oil absorption was observed in variety Kufri Chipsona-1 (9.1%) when fried at 190°C with the slice thickness of 0.5mm followed by variety Kufri Chipsona-3 (9.9%) with the same slice thickness. The order of the oil absorption among different temperatures in varietiesKufri Chipsona-1 and Kufri Chipsona-3 was of the order of 18.8>13.8>9.1, 13.7>17.0>9.9 at 180°>170°>190° and 170°>180°>190°, respectively.

Table 1. Effect of different temperature, slice thickness and frying time on chip colour and oil absorption

Variety	Frying temperature (°C)	Slice thickness (mm)	Frying time (minutes)	Chip colour	Oil absorption (%)
Kufri Chipsona-1	170	0.2	4.0	1.0	29.70
		0.3	8.0	1.5	29.10
		0.4	14.0	1.5	18.60
		0.5	16.0	2.0	13.80
	180	0.2	3.0	2.5	20.20
		0.3	7.0	2.5	20.90
		0.4	11.0	3.9	19.80
		0.5	13.0	3.0	18.80
	190	0.2	3.0	2.8	17.70
		0.3	6.0	4.5	15.70
		0.4	10.0	1.5	11.00
		0.5	12.0	1.6	9.10
Kufri Chipsona-3	170	0.2	6.0	1.5	31.10
		0.3	10.0	4.0	25.30
		0.4	14.0	4.5	23.40
		0.5	18.0	4.5	17.00
	180	0.2	4.0	2.0	31.00
		0.3	9.0	4.5	28.60
		0.4	11.0	4.5	19.60
		0.5	17.0	4.0	13.70
	190	0.2	4.0	2.3	27.70
		0.3	6.0	5.6	15.60
		0.4	10.0	6.0	13.50
		0.5	15.0	5.9	9.90
(S.Em.)± *CD (0.05)					
Temperature			(0.10)	(0.05)	(0.05)
			0.31**	0.17**	0.16**
Temperature x			(0.25)	(0.13)	(0.12)
Thickness			0.77**	0.41**	0.39**
Variety x temperature.x			(0.36)	(0.19)	(0.181)
thickness			1.1*	0.58*	0.58**

*CD=Critical difference **significant at 5% level.

Reducing sugars concentration was assessed in raw potato tubers and after frying of potato chips to know the behaviour of nutritional composition. Colour of the potato changes during processing. To minimize the production of dark-coloured chips low reducing sugars varieties are preferably used. Reducing sugars in raw potato tubers in both the varieties viz., Kufri Chipsona-1 and Kufri Chipsona-3 was 89.33 and 92.16 mg/100g FW respectively. Reducing sugars was within the acceptable limit in raw potato tubers. Reducing sugars in fried chips were determined within the range of 11.03 to 22.83 mg/100g FW (Table 2). The lowest reducing sugars content was found in Kufri Chipsona-3 (10.21) and Kufri Chipsona-1 (11.03), respectively. Comparative studies has shown that in varieties Kufri Chipsona-1 maximum % reduction, after frying was of the order of 77.9 % was found at 180 °C with 0.2mm thickness followed by at 170 °C with the same thickness (77.0%). Least % decrease was acquired at 170°C with 0.5mm thickness. In another variety Kufri Chipsona-3, maximum % reduction (81.1%) in reducing sugars was noticed at 180°C with 0.2mm thickness. Similarly, at 170°C with 0.2mm thickness showed 80.2 % reduction in reducing sugars after frying of potato chips. Potato stored at temperatures below 10C accumulate reducing sugars more as compared to storage at higher temperatures.Due to low temperature stress, sucrose present in tubers gets converted to glucose and fructose by the vaculor enzyme acid invertase that get activated during storage.

Sucrose content after frying was recorded 219.36 to 674.9mg/100gFW. Whereas in raw potato tubers it was 636.70mg/100g FW. Sucrose present in potato tubers does not anticipate directly during frying mechanism and serve as a substrate for reducing sugars via storage activated enzyme invertase. Processing quality of potato tubers are considered optimal when sucrose and glucose contents are minimal (Table 2). Sucrose content at 0.5mm thickness was 674.9mg/100g FW (170°C), 219.3 mg/100gFW) (180°C) and 329.4mg/100g FW (190°C) in variety Kufri Chipsona-1, which was statistically different with each-other. Another variety, Kufri Chipsona-3, with the same thickness of 0.5mm obtained 457.4, 469.0 and 426.2 mg/100g FW at three different temperatures (170, 180 and 190°C) and values were statistically at par with each-other. It was observed that after frying sucrose content did not followed a consistent pattern.

Raw potato tubers contained 56 to 64.8mg/100g phenol content. Data presented in Table 2 depicts that phenols after frying ranged from 89.95 to 178.6 mg/100 g FW with minimum and maximum values exhibited by variety Kufri Chipsona-1 and Kufri Chipsona-3 at 170 °C and 180 °C with 0.2mm and 0.5mm thickness, respectively. The variety Kufri Chipsona-3 recorded 157.6 mg/100 g FW when samples were subjected to 190 °C. When comparing the phenol content in potato varieties after frying process both the varieties showed higher values than the raw potato. Phenols increased irrespective of the slice thickness (Table 1). Variety Kufri Chipsona-1 at 170 °C with different slice thickness indicated phenols, 178.6 (0.5mm), 151.1 (0.4mm) and 114.3 (0.3mm) and 90.8 (0.2mm) mg/100g FW. Trend followed at 180°C with the same thickness was equal. In variety Kufri Chipsona-3, the accumulation of phenols at 170 °C in variety Kufri Chipsona-3 had lesser amounts on comparing with phenol values at 180 and 190°C temperature.

Table 2. Effect of different temperature after frying on reducing sugars, sucrose and phenols.

Variety	**Frying temperature (°C)**	**Slice thickness (mm)**	**Biochemical parameters**		
			Reducing sugars (mg/100g FW)	**Sucrose (mg/100g FW)**	**Phenols (mg/100g FW)**
Kufri Chipsona-1	170	0.2	11.0	416.8	90.8
		0.3	16.3	482.8	114.3
		0.4	20.7	628.2	151.1
		0.5	22.8	674.9	178.6
	180	0.2	13.9	421.0	98.9
		0.3	15.4	439.2	116.8
		0.4	20.7	491.8	127.9
		0.5	22.2	505.8	138.4
	190	0.2	17.4	219.3	137.2
		0.3	16.6	263.1	147.8
		0.4	15.9	292.6	149.6
		0.5	14.8	329.4	149.3
Kufri Chipsona-3	170	0.2	15.9	304.5	90.0
		0.3	16.8	332.6	97.7
		0.4	18.1	410.4	108.4
		0.5	20.4	457.4	113.9
	180	0.2	10.2	284.5	123.5
		0.3	17.0	336.4	128.6
		0.4	17.8	368.0	130.1
		0.5	18.7	469.0	135.0
	190	0.2	15.2	405.7	157.6
		0.3	18.1	358.5	133.5
		0.4	13.0	424.5	129.9
		0.5	16.0	426.2	132.6
(S.Em.)±CD (0.05)					
Temperature			(0.118) 0.408**	(4.2) 14.4**	(1.18) 4.09**
Temperature x Thickness			(0.23) 0.81*	(8.35) 28.9*	(2.36) 8.19**
Variety x Temperature.x Thickness			(0.33) 1.15**	(11.8) 11.5**	(3.34) 11.5*

(mg/100g FW)= milligram per 100g Fresh weight, CD=Critical difference **significant at 5% level.

The sensory scores of two varieties of potato chips as modified by varying thickness and temperatures of two varieties Kufri Chipsona-1 and Kufri Chipsona-3has been shown in Figure 3. Chips from two varieties Kufri Chipsona-1 and Kufri Chipsona-3 were acceptable to the panelists irrespective of the frying temperature. In processing variants, the temperature at which potato chips were fried had no effect on the colour or flavour of the chips. The overall acceptance of 2mm slices was higher than 3mm, 4mm, and 5mm slices. The brittle and crunchy texture of little sliced chips might have contributed to this. This suggests that customers may distinguish crisp from soggy depending on the amount of oil absorbed as a function of slice thickness. Slice thickness has an effect on the colour score of potato chips, the smaller was the slice the highest was the chip score. Color of the food surface is the first quality parameter evaluated by consumers and it is critical in the acceptance of the product, even before it enters the mouth [25].

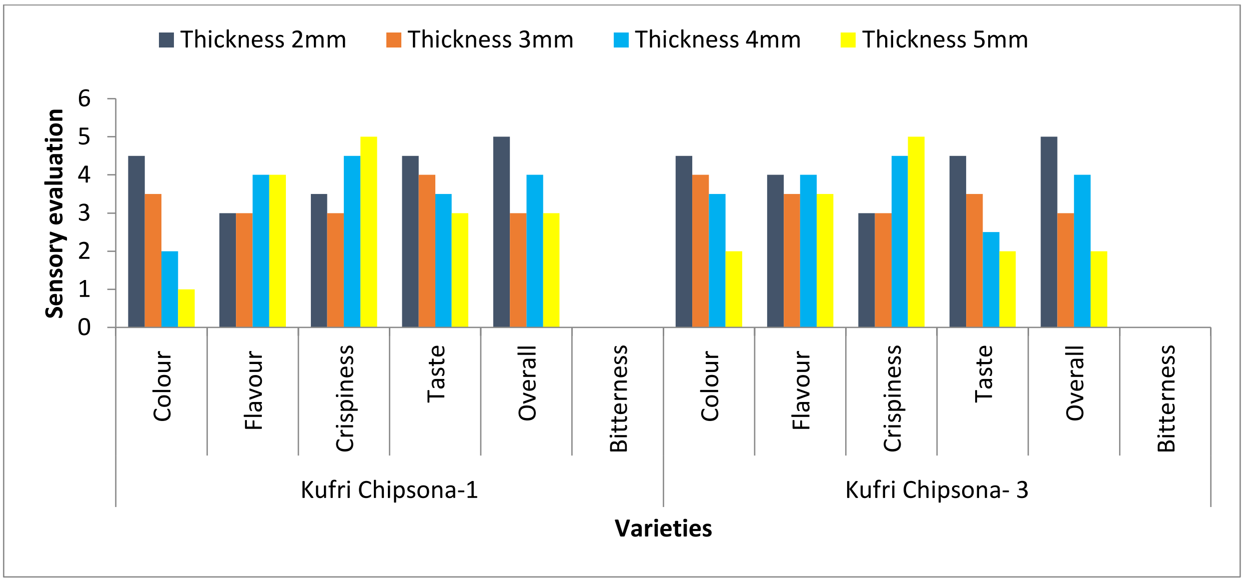


Figure 3. Sensory evaluation of varieties.

DISCUSSION

Variety-temperature interaction had no significant (p>0.05) effect on frying time. Similar results were obtained from the previous studies who reported [17], that frying temperature had no significant effect on potato crisps. As the slices were immersed in pre-heated oil, the heat from hot oil immediately transferred inside the slices. It is quite well understood that moisture might have started to evaporate as the temperature reached the boiling point. However, at a frying temperature (170, 180 and 190 C) did not showed any significant effect.

It was observed that more was the thickness of potato slice less was the oil absorption. Results obtained are in agreement with the results [18] that increase in potato slice thickness resulted in decreased oil content and emphasized that product size is another factor that affects the final oil content of fried products. Similar results were observed by other authors [19,20] who noted that thinner potato strips retained more oil after frying than thicker strips. A study on effect of pre-drying on fat content of potato chips reported that lower temperature is associated to the higher fat which hold true for our results reported [20]. However, the relation between the oil and moisture content of potato chips and their crispy texture still unclear. Contradictory results have been reported on the effect of oil temperature on final oil content of fried products. Final oil content was not directly related to the frying temperature [7]. Contrary to this, it has been reported that the final oil content of French fries increased with increase in frying temperature [19]. In another study, [9] and [22] noticed that oil content decreased with increase in oil temperatures.

Reducing sugars concentration is an important parameter to measure as this is a precursor to the formation of Malliard reaction. Changes in the reducing sugars content indicated that the reaction had occurred. Higher concentration of sugars remaining after frying or processing is considered better indicating that precursor has not been used during the Malliard reaction. It has been well established that end colour products changes are mainly affected by the reducing sugars [22]. Correlation studies indicated significant positive correlation between chip colour and different biochemical parameters, sucrose [r=0.901], phenols [r= 1.000] and reducing sugars [r= 0.626] of the tested varieties. The co-efficient presented that the parameters were responsible for the browning and darkening of potato chips. Fresh harvest of potato tubers contains very low amount of sucrose content and potato tubers, if fried, does not participate and results in change colour. The sucrose content of potato tubers mainly participate during the storage period [23]. Sucrose mainly serve as the substrate for reducing sugars production via the storage activated enzyme invertase.

Phenol content in processed chips was found to be almost double the values than raw potato. Interaction between temperature and slice thickness was found to be highly significant ($p>0.05$). The results are in accordance with the results [24] who observed that phenols increase in potato chips after frying. This can be explained by the fact that increase in phenol content is may be because of higher temperature lead to pyrolysis of phenolic compounds present in cell-wall as majority of phenolic acid is found attached to cell wall structural components. Bound phenolic acids are released and aided by a variety of food processing methods, including thermal processing, pasteurisation, fermentation, and freezing. The enzymatic darkening is caused by higher polyphenol concentration. Because low reducing sugar and polyphenol amounts are essential to avoid dark colour and bitter flavor.

CONCLUSION

The conclusion that can be drawn from these results is that the temperature affect the chip colour of the potato. Time too varies with the increase in different slice thickness of potato. More slice thickness tends to reduce the oil absorption in slices from the frying media as compared to decreased slice thickness. Slice oil was less absorbed at a temperature of 190°C. Less reduction in reducing sugars after processing symbolized that the content actively participated during the frying mechanism. After cooking darkening indicated that phenols at higher temperature is affected markedly. Evaluation of chipping quality and biochemical parameters only could be possible as the conditions were controlled thermostatically or under laboratory conditions. In un-organised sectors, where large amount of fried products are sold from open fried chambers, still most of the parameters remain un-mined.

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