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Full Length Research Paper

Impact of Apple Pomace Powder on Fish Finger Qualitative Characteristics

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A The goal of the current study was to assess how various concentrations of apple pomace powder (APP) affected the fish finger qualitative attributes. In order to replace fish meat in the formulation, apple pomace powder was added at four different percentages: 0, 2.5, 4.5, and 6.5. Numerous physicochemical characteristics, sensory qualities, emulsion stability, cooking yield, pH, and proximate composition (i.e., crude protein, fat extract, moisture content, and total ash) were examined in the products. As the amount of apple pomace powder was increased, there was a noticeable increase in both emulsion stability and cooking yield. The product's pH, crude protein, moisture, crude fat, and total ash all showed a significantly ($p < 0.05$) declining tendency as the amount of apple pomace powder added increased.

Key words: Fish fingers, Apple pomace powder, Physico-chemical properties, Textural properties, Sensory evaluation, Refrigerated storage.

INTRODUCTION

Frill fin Ready-to-eat food has become a popular commodity due to the fast-paced nature of modern life and the ongoing global demand for these products. As a result, fish and fish products may be viable sources of this type of diet. In addition to other nitrogenous components, fish is a good provider of nutritional proteins, lipids, carbohydrates, minerals, and vitamins [1]. Additionally, it has a high content of omega-3 unsaturated fatty acids, which have numerous health advantages, and a low cholesterol content [2]. Fish and fish products, on the other hand, are thought to be a poor source of dietary fiber, and eating meals low in fiber may increase your risk of developing chronic illnesses including obesity, heart disease, and colon cancer. Dietary fiber consumption may lower the chance of developing various chronic illnesses, according to reports [3, 4]. Dietary fibers have a number of beneficial physiological impacts on human health, including lowering blood sugar and cholesterol and reducing diseases connected to digestion. There have been numerous attempts to add dietary fibers, such as wheat bran, oat bran, barley bran, etc., to fish and fish products. In addition to having some antioxidant potential, the current tendency is to identify a non-meat product that can supply enough fiber. In this sense, powdered apple pomace may be utilized as a possible fiber source in fish products.
One common food that contains dietary fiber is apples (Malus domestica) [5]. The solid portion that remains after pressing apples to get their juice—which includes the pulp, skins, and cores—is called apple pomace. It has been shown to have great antioxidant action, limit the growth of cancer cells, reduce lipid oxidation, and lower cholesterol. It is regarded as a rich source of phytochemicals. Apple pomace powder, a rich source of several nutrients, has been incorporated into the recipes of a number of meat items. However, there is currently either very little or no published research on the use of powdered apple pomace in fish products. Consequently, the current

The purpose of the study was to determine how different concentrations of apple pomace powder affected the physicochemical and functional characteristics of fish fingers as well as the shelf life of the generated fish fingers at 4 ± 1ºC.

Material and Methods

Raw materials

Fish meat: A local fish market in Sopore Baramulla provided the fresh fish, which was then transported to the Islamic University of Science and Technology's FPTC laboratory in Awantipora for additional processing. Fish were deboned using the precooking process after dressing.

Apples: Apples (*Malus domestica*) were purchased from local fruit market of Awantipora.

Condiments: Condiments were prepared by making a fine paste of onion, ginger and garlic in the ratio of 4:3:1.

Spice mixture: Table 1 lists the several spices used in the fish finger preparation mixture, which were bought from the neighborhood market.

Flours: Water chestnut flour was purchased from the local market of Awantipora.

Table 1. *Composition of spice mixture.*

Spices	Percentage (%)
Black cardamom (*Badi elaichi*)	5
Cinnamon (*Dalchini*)	20
Turmeric (*Haldi*)	10
Clove (*Loang*)	5
Red chilli	10
Coriander (Dhania)	20
Cumin (*Zeera*)	10
Black pepper (*Kalimirch*)	10
Aniseed (*Soanf*)	10
Total	**100**

Salt: Salt (Tata) was purchased from the local market.

Packaging materials: The final product was packaged for storage study using LDPE pouches that were bought from the Srinagar local market. Using a weighing balance, the weight of the fish fingers for each treatment was measured in order to calculate the cooking yield, which was then calculated as a percentage of the raw weight. Fish fingers were weighed both before and after frying. The cooking yield was calculated using the formula:

$$\text{Cooking yield } (\%) = \frac{\text{Weight of cooked fish finger}}{\text{Weight of uncooked fish finger}} \times 100$$

Methods

Apple pomace powder preparation:

Apples were sliced into tiny pieces and crushed in an electric crusher after being cleaned and corked. After being crushed, the pulp was compressed in a hydraulic press and dried for two days at 80 degrees Celsius in a hot air dryer.

Product preparation: Table 2 shows the four different formulation types that were created, with the amount of apple pomace powder ranging from 0.0% to 6.5%.

The technique outlined by Tokur et al. [6] was used to prepare the fish fingers. To obtain their fillets, the fish samples were decapitated, gutted, and cleaned. Meat was properly minced in a grinder for a few seconds after adding salt and ice flakes. In accordance with the recipes listed in Table 2, the ingredients—spice mixture, condiments, flour, salt, and apple pomace powder—were added to the minced meat. For a while, weighed amounts of the four emulsion kinds (Control, T-1, T-2, and T-3) were placed in a deep freezer. These were then chopped into pieces and sliced to obtain fingers. After being coated in bread crumbs, the fish fingers were cooked for 30 seconds at 180 degrees Celsius in sunflower oil. Enough samples were taken from each treatment for physico-chemical analysis, and the rest were packed in LDPE pouches and kept at 4 ± 1oC.

Analytical procedures

In the present study apple pomace powder was incorporated as a source of dietary fibre at four different levels i.e., control (0%), T-1 (2.5%), T-2 (4.5%), and T-3 (6.5%). All four types of products (control and treatments 1, 2 and 3) were evaluated for various parameters such as physico-chemical properties, proximate composition, texture profile analysis, sensory attributes and microbiological analysis.

Physico-chemical analysis

pH determination: Using a digital pH meter (Model: LABINDIA), Tokur et al.'s approach was used to measure the pH of fish finger samples shortly after they were prepared [6]. 50 milliliters of distilled water were mixed with 10 grams of the sample. The digital pH meter's combination glass electrode was dipped into the suspension to record its pH.

Cooking yield:

Table 2. *General formulation for the control and treatment fingers.*

Ingredients(g)	Control	T-1	T-2	T-3
Fish meat (g)	170	170	170	170
Salt (g)	7.5	7.5	7.5	7.5
Ice(g)	9	9	9	9
Condiment mix. (g)	7.5	7.5	7.5	7.5
Spice mix. (g)	7.5	7.5	7.5	7.5
Flour (g)	60	52.5	46.5	13.5
Apple fibre (g)	0	7.5	13.5	19.5

Proximate composition: The AOAC vv standard method was used to estimate the approximate composition of fish fingers in terms of moisture content, carbohydrate, ash, crude fat, crude fiber, and crude protein.[7].

Thiobarbituric acid value: Thiobarbituric acid value of Fish fingers during storage was determined using the method of Witte et al. [8].

Texture Profile Analysis: Using the method described by Bourne, the Instron Texture Analyser (TA.HD. Plus, Stable Micro Systems, Godalming, Surry, UK) connected to a texture expert software program was used to perform Texture Profile Analysis (TPA) of fish fingers [9]. The test samples were uniformly sized pieces. Using a 25 kg load cell, they were positioned on a platform on a fixture and compressed to 50% of their initial height in a two-cycle sequence at a cross head speed of 5 mm/s. The following parameters were established: Adhesiveness (kg): Negative area under baseline between the compression cycles or A3; Hardness (kg): Peak force/energy needed to compress the sample; Cohesiveness: the amount of deformation that the sample might undergo before rupturing (A2/A1, where A1 is the maximum force needed for the first compression and A2 is the maximum force needed for the second); Springness (mm): the sample's capacity to regain its initial height following the removal of the deforming force, measured in the period between the first compression and its end; Gumminess(mm): (hardness × cohesiveness); Chewiness(kg): (Springness × gumminess).

Sensory evaluation: Using a five-point hedonic scale—five being excellent, four being good, three being fair, two being acceptable, and one being not acceptable—the

sensory attributes—appearance and color, flavor, taste, texture, and overall acceptability—were assessed [10]. To ascertain the fried fingers' sensory qualities, a panel of seven faculty members from the Islamic University of Science and Technology, Awantipora's Food Science and Technology department were given them. The panelists were given coded samples at random. The panelists were briefed on the nature of the experiment without revealing the samples' identities. In between samples, there was water available to rinse the mouth. The panelists evaluated the items based on their taste, texture, color, flavor, and appearance.

Colour measurement: Hunter Color Lab was used to measure the color of fish fingers. Before the samples were measured, the equipment was standardized. Fish finger values were assessed for Hunter L* (lightness), a* (redness/greenness), and b* (yellowness/blueness). For every formulation, three samples were examined, and the average value was calculated by combining measurements from three distinct points on a single sample.

Microbiological evaluation

Using a routine procedure, the samples' total plate count, yeast count, and mold count were ascertained [11]. Glassware was autoclaved in a MAC Autoclave Vertical (Model: Narang Scientific Works, PVT LTD, New Delhi) for 15 minutes at 121 oC. In a horizontal laminar flow cabinet (Model: Narang Scientific Works, PVT LTD, Delhi-202) that had been pre-sterilized by ultraviolet irradiation while adhering to all aseptic conditions, samples were prepared and serial dilutions were carried out close to the flame.

Preparation of homogenate: After mixing roughly 10g of the sample with an approximate volume of the diluent (sterile 0.1% peptone water), it was homogenized for 30 to 60 seconds in a vortex (Model: SPINIX).

Preparation of serial dilution: Using a pipette for the initial dilution (10-1), 1 ml of sample homogenate was placed into a tube with 9 ml of diluent for serial dilution. One milliliter from the first dilution was moved to the second tube, which had nine milliliters of sterile 0.1% peptone water, for the second dilution (10-2).For the third (10-3) dilution, 1 milliliter of this solution was moved to a different tube. Until the desired result was achieved, the process was repeated.

Total plate count: Prior to plating, approximately 28g of nutritional agar was autoclaved after being dissolved in 1000 ml of distilled water. Sterilized medium (around 15–20 ml) was well mixed. Nutrient agar was put into sterilized petriplates, and 1 cc of inoculum from each of the 10-1, 10-2, 10-3, and 10-4 dilutions was added. The plates were incubated for 24 to 48 hours at 35 degrees Celsius inverted in a B.O.D. incubator (Caltan Super Deluxe Automatic, Model: Narang Scientific Works, Pvt. Ltd., New Delhi-152). The average number of colonies was multiplied by the reciprocal of the dilution factor to determine the Cfu/g, which was then reported as log cfu/g.

Yeast and mould count: Mold and yeast counts were determined using potato dextrose agar. One liter of distilled water was mixed with 39 grams of potato dextrose agar (PDA), and the mixture was autoclaved. After being put into petriplates, the media was left to harden. The petriplates were incubated for 24 to 48 hours at 25 °C following inoculation. Yeasts developed tiny, distinct colonies and had a blue-green or white appearance. Compared to yeast colonies, mold colonies were often bigger and blue. The total number of colonies or plates of yeast and mold was multiplied by the appropriate dilution factor, and the result was represented as log cfu/g.

Statistical analysis

The statistical design was a randomized block design with four treatments and three replications. In order to determine the impact of treatments, storage times, and their interactions for different parameters in various experiments, the generated data was compiled and analyzed using Minitab 16 for the analysis of variance (ANOVA) and Duncan's test (at 5% significance level)[12].

Results and Discussion

Proximate composition of raw meat

Table 3 shows the proximate composition and pH of fresh fish meat. The findings concur with those of Levent ICZI's earlier study on fish meat [13]. According to proximate analysis, the control samples had a higher moisture content than the ones that contained apple pomace powder. As the concentration of apple pomace powder increased, the treatments' moisture content dropped. The reduced moisture content of apple pomace powder may be the cause of this drop in moisture content. The findings go counter to Verma et al.'s [14] observation that the moisture content of the emulsion gradually increased as the amount of guava powder substituted in the sheep meat nugget increased. Fish fingers had a considerably ($p < 0.05$) higher fat content than T1 (2.5%), T2 (4.5%), and T3 (6.5%). The fat content of T3 (6.5%) was considerably ($p < 0.05$) lower than that of T1 (5%) and T2 (10%), respectively, among the treatments. The higher amount of apple pomace powder may be the cause of this drop in fat content. These results are consistent with those that Huda et al. [15] reported. The addition of orange, apple, and peach fibers to dry fermented sausages similarly decreased their lipid level, according to Garcia et al. [16]. As the amount of apple pomace powder increased, the mean values of total ash exhibited a dramatically declining trend. The reduced ash level in apple pomace powder may be the cause of this drop in the overall ash content. These results are consistent with those of Mendoza et al. [17], who noted a comparable pattern in dry fermented sausage made from calf fat that had inulin added as a fat substitute. Control had a considerably ($p < 0.05$) higher protein content than T1 (2.5%), T2 (4.5%), and T3 (6.5%). The more apple pomace powder added to the treatments, the lower the protein amount became ($p < 0.05$). This was consistent with research by Huda et al. [15], who discovered that adding apple pomace decreased the amount of protein in mutton nuggets. According to Alonso et al. [18], the percentage of protein in fish muscle that had grape dietary fiber added dropped as GADF levels rose. As the amount of apple pomace powder was increased, the crude fiber values exhibited a significantly ($p < 0.05$) increasing trend. The greater fiber content of apple fiber may be the cause of the notable increase in crude fiber values. Similar increases in crude fiber were noted by Huda et al. in mutton nuggets with apple pomace [15]. According to Fernandez-Gines et al. [19], bologna sausages' fiber content rose when lemon albedo, a significant component of lemon peel, was used as a dietary fiber source.

Effect of apple pomace powder on the physico-chemical properties of fish fingers

The results of pH, emulsion stability and cooking yield of developed fish fingers with 0, 2.5%, 4.5% and 6.5% apple

Table 3. *pH and proximate composition (%) of raw fish flesh.*

Parameters	Value
Moisture (%)	76.20 ± 0.05[a]
Ash (%)	1.54 ± 0.02[e]
Crude fat (%)	2.53 ± 0.03[d]
Crude protein (%)	17.25 ± 0.03[b]
pH	6.22 ± 0.11[c]

All values are average of three determinations (n=3)

Table 4. *Effect of apple pomace powder on the physico-chemical properties of fish fingers.*

Parameters	Control	T_1	T_2	T_3
pH	6.39 ± 0.68[a]	6.18 ± 0.05[b]	5.96 ± 0.03[c]	5.84 ± 0.07[c]
Emulsion stability (%)	89.17 ± 0.03[a]	89.90 ± 0.02[b]	90.25 ± 0.02[c]	91.65 ± 0.04[c]
Cooking yield (%)	91.21 ± 0.05[a]	91.74 ± 0.11[b]	91.97 ± 0.03[c]	92.11 ± 0.10[d]

All values are average of three determinations (n=3)

Row-wise values bearing different superscripts (small) differ significantly (p ≤ 0.05)

Control: fish fingers with APP (0%)

T1: Fish fingers with APP (2.5%)

T2: Fish fingers with APP (4.5%)

T3: Fish fingers with APP (6.5%)

pomace powder are depicted in Table 4.

pH

Table 4 reports the pH values for the control and apple pomace powder-incorporated fish fingers. The findings showed that as the amount of apple fiber integrated increased, pH values exhibited a decreasing tendency. The slight sourness of apple fiber may be the cause of this pH drop. The findings of Cadun et al. [20], who documented that the impact of fibers on the quality of fish patties held at 0–4oC led to a progressive drop in pH as the apple fiber was added, are in line with the decline in pH scores. According to Verma et al. [21], adding apple pulp to low-fat chicken nuggets caused the pH of the final product to gradually drop as the amount of apple pulp grew. The current study's pH results are consistent with those of Verma et al., who also found that adding guava powder to sheep meat nuggets decreased their pH value [21].

Emulsion stability

The more apple pomace powder there was in the mixture, the more stable the emulsion became. The introduction of apple pomace powder may have increased the stability of the emulsion since it caused a linear drop in pH. These results are consistent with those of Choi et al., who found that adding dietary fiber to meat products increased their emulsion stability [22]. Fernandez-Gines et al. similarly showed similar outcomes with bologna sausage that had varying amounts of orange fiber [19].

Cooking yield

The results of cooking determinants indicated that the control had significantly ($p \geq 0.05$) lower cooking yield than T_1 ash, crude fibre, crude fat and protein) of fish fingers is shown in Table 5.

Sensory attributes of fish fingers

Table 6 displays the findings of the sensory assessment of fish fingers that have been mixed with apple pomace powder, including appearance, color, flavor, juiciness, and texture. The majority of the sensory qualities were significantly impacted by the addition of fish fingers with apple pomace powder. As the amount of apple pomace powder increased, there was a significantly ($p < 0.05$) declining trend in the incorporation of fingers. Juiciness, color, and appearance all displayed comparable trends. At every level of inclusion, however, flavor had a noticeable impact. Once the integration level was above 4.5%, a considerable effect was seen. Huda et al. have reported similar outcomes with mutton nuggets[15].

Texture profile analysis

An Instron Texture analyzer (TA.HD. Plus, Stable Micro Systems, Godalming, Surrey, UK) was used at the Department of Food Technology, Awantipora, to assess the textural characteristics of fish fingers. The mean values for each treatment's TPA parameters were determined using force-by-time data from each test. Table 7 displays the findings of the control and treatment texture profile analyses. In comparison to treatments containing varying amounts of apple pomace powder, the control group's hardness, gumminess, and chewiness values were considerably ($p \leq 0.05$) lower. The reduction in hardness among the treatments may potentially be caused by high moisture retention.

Table 5: *Effect of Apple pomace powder on the proximate composition of fish fingers.*

Parameters	Control	T_1	T_2	T_3
Moisture (%)	67.28 ± 0.03[a]	66.92 ± 0.26[b]	66.44 ± 0.03[c]	66.02 ± 0.01[d]
Crude protein (%)	18.08 ± 0.02[a]	17.46 ± 0.02[b]	16.89 ± 0.05[c]	16.30 ± 0.02[d]
Crude fat (%)	8.90 ± 0.01[a]	8.08 ± 0.00[b]	7.38 ± 0.05[b]	7.05 ± 0.03[c]
Ash (%)	2.43 ± 0.04[a]	2.29 ± 0.02[ab]	2.24 ± 0.06[b]	2.15 ± 0.06[b]
Crude Fibre (%)	0.42 ± 0.04[a]	1.66 ± 0.04[b]	2.58 ± 0.08[c]	3.27 ± 0.02[d]

All values are average of three determinations (n=3)

Row wise mean values bearing different superscripts (small) differ significantly (p ≤ 0.05)

Control fish fingers with APP (0%)

T1: Fish fingers with APP (2.5%)

T2: Fish fingers with APP (4.5%)

T3: Fish fingers with APP (6.5%)

(2.5%), T_2 (4.5%) and T_3 (6.5%). Among the treatment groups cooking yield increased significantly ($p \leq 0.05$) with increasing levels of apple pomace powder as shown in Table 4. Alonso et al., [18] reported that the addition of fibre increased the cooking yield in minced fish muscle. Similar findings were documented by Huda et al., [15] in mutton nuggets. Besbes et al. [23] also reported that the use of dietary fibres from pea and wheat as a meat replacement in beef burger patties increases cooking yield but decreased shrinkage. The results are also in agreement with those reported by Mitsyk and Mikhailovskii [24].

Proximate composition of fish finger

The proximate composition (moisture, carbohydrate, total Cadun et al. have observed similar findings [20]. The cohesiveness value of the control group was substantially ($p < 0.05$) greater than that of the treatment groups. By adding apple pomace to mutton nuggets, Huda et al. noticed the same pattern [25]. According to Mendoza et al., adding dietary inulin to low-fat sausage caused its cohesion to diminish [17]. Compared to treatments, the control group's chewiness values were substantially greater ($p < 0.05$). Compared to the control, fish fingers made with 2.5%, 4.5%, and 6.5% apple pomace powder were less chewy. Additionally, Lin and Lin noted that Chinese-style meatballs with bacterial cellulose (Natta) had less chewiness [26].

Storage studies

Colour analysis: Table 8 provided the color parameter variations over the storage time. During the storage period, fish fingers containing apple pomace powder had significantly greater L* (lightness) and b* (yellowness) values than the control group ($p<0.05$). According to Cadun et al., adding apple fiber considerably raised the L and b value [20]. Sanchez Alanso et al. confirmed similar findings, stating that the

The b* value was considerably raised by the addition of wheat fiber [18]. The fish fingers are influenced by the color of the dietary fiber.

Effect of storage on the sensory properties of fish fingers: After 15 Tokur days of refrigeration (4 ± 1ºC), the fish fingers were assessed for changes in sensory characteristics. Table 9 displays the average value of several sensory characteristics, including appearance, flavor, juiciness, texture, and general acceptability over storage. According to sensory evaluations, fish fingers were deemed satisfactory. According to the results, the control group's sensory qualities on the first day of storage were noticeably better than those on the fifteenth day. Between storage days, there was a substantial difference ($P<0.05$) in the fish fingers' sensory attribute scores. All sensory qualities showed a notable downward tendency over the course of the storage days; however, during the storage period, sensory attributes were similar across the treatment and control groups. The pigment and lipid oxidation that causes non-enzymatic browning may be the cause of the decline in appearance scores.

pH: The effect of storage on apple pomace powder incorporated fish finger is depicted in Table 10. The effect of storage was obvious on the pH of fish fingers followed a decrease trend at progressive storage intervals. The pH followed a uniform trend up to 10^{th} day of storage, however beyond 10^{th} day of storage it didn't show much difference in T3 and T4 pH showed a slight increase. This decrease in pH during storage could be attributed to the availability of more readily carbohydrate molecule. Cadun et al. reported the same trend with the increase of apple fibre in fish patties pH values gets decreased [20].

Thiobarbituric acid (mg MA/kg): The Thiobarbituric acid (TBA) followed a significantly ($p \leq 0.05$) increasing trend during the entire storage period of 15 days. The increase was observed both in control and apple pomace powder treated products. However the rate of increase of TBA was higher in control and lowest in T3 (Table 11). The lower rate of increase in apple pomace powder treated products could be attributed to the presence of antioxidant substances in apple pomace powder. Kose et al. [27] reported the same trend of meat prepared from unwashed mince products, washed mince products and precooked mince products, respectively. Similar increase in the TBA was observed by Taskaya et al. in fish burger [28].

Microbiological quality of fish fingers during refrigerated storage (4 ± 1ºC): The microbiological properties of fish fingers (control and treatments packaged in LDPE) at refrigeration temperature (4 ± 1ºC) for 15 days.

Total plate count

Mean values of total plate count (TPC) (log cfu /g) of control and apple pomace powder incorporated fish fingers during refrigerated storage are presented in Table 12.

Microbial analysis revealed mean total plate count of control and treatments showed a significant ($p \leq 0.05$) increasing trend at progressive storage intervals with a slight difference although non-significant ($p \geq 0.05$) in total plate count of control and treatments during storage. Total plate count ranged from 1.52-3.22 log cfu/g during refrigerated storage which was much below the incipient spoilage level of 7.0 $\log_{10}$ cfu/g [29]. This might be the result of adding salt, other spices, and condiments to the fish fingers, which have potent antibacterial properties. The antibacterial action of apple pomace powder and the lower pH of treated groups compared to control may be the cause of the lower total plate counts of fish fingers made with this powder, which inhibited microbial development. The bioactive substances found in fiber, particularly polyphenols and terpenes, may also be responsible for the antibacterial activity. Several researches found that different fish items kept in a refrigerator had the same rise in the number of bacteria [28, 30, 31]. The identical pattern was noted by Praneetha et al. when fish fingers were kept in a refrigerator [32]. When examining the impact of binders and precooked meat on the quality of chicken loaves at refrigeration temperature, Reddy and Rao noticed a comparable

rise in the overall number of plates [33]. According to Viuda-Martos et al., adding orange dietary fiber to vacuum-packed bologna sausage resulted in a lower TPC than the control [34].

Yeast and mould count

Yeast and mould count (log cfu/g) of control and apple pomace powder incorporated fish fingers during refrigerated storage are presented in Table 13.

Table 13. *Influence of refrigerated storage (4 ± 1°C) on yeast and mould count of fish fingers.*

Treatment	Storage period (days)			
	0	5	10	15
Control	ND	ND	ND	1.61^{aA} ± 0.10
T_1	ND	ND	ND	0.83^{aB} ± 0.05
T_2	ND	ND	ND	0.65^{aBC} ± 0.04
T_3	ND	ND	ND	0.36^{aC} ± 0.04

All values are average of three determinations (n=3)

Row-wise mean values bearing different superscripts (small) differ significantly (p 0.05)

Column –wise mean values bearing different superscripts (capital) differ significantly (p ≤ 0.05)

Control: Fish fingers with APP (0%) T1: Fish fingers with APP (2.5%) T2: Fish fingers with APP (4.5%) T3: Fish fingers with APP (6.5%)

Up until the tenth day of storage, neither the yeast nor the mold count was found in the control or apple pomace powder-treated fish fingers. The count of mold and yeast was substantially ($p < 0.05$) greater for the control group than for any of the other treatments. The difference between the treatments' yeast and mold counts was not statistically significant ($p > 0.05$). On days 0 and 10 of storage, there was no sign of yeast or mold. Following the fifteenth day of storage, there was a substantial rise ($p < 0.05$) in both the control and treatment groups. High heat treatment, proper hygiene, and the lack of post-cooking contamination may be the reasons for the early storage period's lack of yeast and mold. Along with the longer fish fingers caused by apple pomace powder, the addition of salt, spices, and condiments may also have contributed to the low yeast and mold level under control. The combined impact of oregano essential oil and orange dietary fiber on microbial development in meat products has been the subject of numerous investigations. [19].

Conclusion

The physico-chemical investigation showed that adding apple pomace powder caused a substantial ($p < 0.05$) drop in the product's pH. The inclusion of apple pomace powder resulted in a significant improvement ($p < 0.05$) in both cooking yield and emulsion stability. Fish fingers' moisture content, crude protein, crude fat, and ash content all significantly decreased ($p < 0.05$) as the amount of apple pomace powder increased, according to proximate composition. The inclusion of apple pomace powder resulted in a significant increase ($p < 0.05$) in the products' crude fiber content.

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Conflict of interest

The authors do not have any conflict of interest.

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