SUMMARY

Efforts were made to utilize sand smelt fish in processing two value-added fish products, namely fish burger and fish fingers. For this purpose, soybean flour (SF) and minced boiled potato (MBP) were evaluated as filling materials at different levels to assess the more suitable levels of these materials to produce such fishery products with good quality and accepted sensory properties. Storage stability of sand smelt fish products was investigated by following up the changes occurred in the chemical characteristics, chemical quality parameters, microbiological safety and sensory properties during frozen storage at \(-81^\circ C\) for 90 days. The results obtained could be summarized in the following points

1. Chemical analysis and microbiological examination of Sand Smelt fish (Atherina hepsetia)

1.1. Chemical analyses showed that moisture, crude protein, crude fat, ash and nitrogen free extract (carbohydrates) contents of sand smelt fish were 85.8%, 55.71%, 83.32%, 20.39% and 5.63% respectively

1.2. The chemical quality parameters: TVB-N and TMA-N of fresh sand smelt fish were determined by 16.8 mg and 27.0 mg, respectively while TBA determined as malonaldehyde was 53.0 mg/kg, and pH value was 5.3 indicating the high freshness and good quality of sand smelt fish used in this work.

1.3. The microbiological examination indicated the microbial load of sand smelt fish which counted by \(7.6\times10^8\) log cfu/g for total bacterial count and \(7.5\times10^8\) log cfu/g, for molds and yeast.

2. Quality characteristics of fish products made from sand smelt fish.

2.1. Using soybean flour (SF) and minced boiled potato (MBP) significantly \((p>.05)\) improved the sensory properties attributes i.e., taste, odor, color, texture and overall quality of fish burgers and fingers made from sand smelt fish comparing
with control samples prepared without adding filling materials. The panelists attributed the low acceptance of control samples of sand smelt fish burgers and fingers to the dark color, the soft texture and the undesirable fishery odor and taste. The higher score values recorded for the formulated burgers and fingers were explained to the effect of filling materials in whitening color, firming the texture and masking the fishery odor. Sensory evaluation data indicated that the more suitable levels of SF and MBP to produce sand smelt fish burger were 10% while for fish fingers the optimum levels of SF and MBP were 2% and 10%, respectively.

Chemical analysis indicated that moisture, protein, fat, ash and carbohydrate contents of sand smelt fish burger were 21.42 - 21.22%, 42.33 - 41.22%, 14.42 - 13.32%, 9.42 - 14.62% and 24.42 - 22.42%, respectively. The proximate chemical composition of fish fingers showed that moisture, protein, fat, ash and carbohydrate contents were 42.34 – 30.12, 43.10 – 50.76, 13.77 – 12.11, 7.88 – 9.77 and 43.43 – 30.93%, respectively.

Storage stability of sand smelt fish products:

Chemical analysis indicated that moisture contents of burger and fingers samples gradually decreased during frozen storage and the loss of moisture increased as the storage period prolonged. At the end of storage period (80 days). The total losses in moisture contents of burger sample were calculated by 8.42, 7.13 and 7.0% in control, 10% SF and 10% MBP samples, respectively while, the moisture losses of control, 2% SF and 10% MBP fish fingers samples were estimated by 10.44, 6.49 and 5.10% respectively. This observation indicated that incorporation of filling materials in the processing of sand smelt fish products improved the water binding capacity in these products during frozen storage.
3.2. The results indicated that protein contents of sand smelt fish burgers and fingers gradually decreased during frozen storage. Protein losses in burger samples stored for 3, 6, and 9 days ranged between 4.77 – 7.41, 12.82 – 14.72 and 24.55 – 41.70%, respectively. Fish fingers samples stored for 3, 6, and 9 days under the same frozen conditions lost about 5.9 – 9.04, 13.26 – 18.8 and 21.3 – 26.7% of their initial protein contents.

3.3. Chemical analysis showed a considerable decrease in fat contents of burgers and fingers samples during frozen storage and the decrease increased as the storage period extended. Fat losses in control burger sample stored for 3, 6, and 9 days were estimated by 93.4, 69.11 and 69.91% respectively. Burger samples formulated with adding filling materials particularly 15% SF showed the higher decreasing in fat content. The percentages of fat loss in 15%SF burger sample were calculated by 10.32, 19.43 and 29.19 % after 3, 6, and 9 days of storage respectively, while after the same periods, burger sample contained 15%MBP lost about 4.5, 13.86 and 25.67% of their initial contents of fat. Finger samples formulated with adding MBP showed the highest loss in fat contents during frozen storage. At the end of 9 days of frozen storage this sample lost more than 4.5%of its fat content.

3.4. The results showed that ash contents of sand smelt fish products increased during frozen storage. Ash content of control burger sample increased from 3.93% (on dry weight basis) at zero day of storage to 10.18, 11.34 and 11.49 % after 3, 6, and 9 days of storage. Also, fish burger formulated by adding SF and MBP showed slight increases in their ash contents. Also, ash contents of fingers samples slightly increased during frozen storage.

3.5. Carbohydrate contents of burger and fingers samples gradually increased during frozen storage. At zero day storage their of
carbohydrates contents of control, 10% SF and 10% MBP burger sample were 27.4, 27.3 and 27.63% (on dry weight basis), respectively while after 9 days of storage carbohydrate contents of these samples were calculated by 34.9, 41.04 and 44.12% (on dry weight basis), respectively. Carbohydrate contents of control, 10% SF, 10% MBP increased from 35.23, 4.32 and 0.93%, respectively at zero time to 43.94, 49.34 and 44.05% at the end of 9 days storage.

3.1. The results indicated that TVB-N showed a wavy progress during frozen storage of sand smelt fish burgers and fingers. At the end of 9 days storage, TVB-N values in control, 10% SF and 10% MBP burger samples were determined by 19.0, 17.6 and 14.7 mg/100 g (wet weight basis), respectively. Also, TVB-N values in control, 10% SF and 10% MBP fingers samples were found to be 71.87, 17.8 and 16.2 mg/100 g (wet weight basis) after 9 days of frozen storage, respectively.

3.2. TMA-N contents of control burger sample and 10% SF and 10% MBP formulated samples gradually increased from 1, 3.8, 1.0 and 1.8 mg/100 g, respectively before storage up to 7.17, 1.89 and 1.74 mg/100 g, respectively at the end of 9 days of frozen storage. The initial levels of TMA-N in control finger sample and the 10% SF and 10% MBP formulated samples increased from 7.4, 7.1 and 0.9 mg/100 g, respectively to 7.87, 7.06 and 1.9 mg/100 g after 9 days storage, respectively.

3.3. TBA values of control, 10% SF and 10% MBP burger samples gradually increased from 1.4, 2.5 and 0.71 mg MDA/kg, respectively before storage to 1.47, 1.3 and 0.97 mg MDA/kg, respectively. The initial values of TBA in control, 10% SF and 10% MBP fingers samples increased from 0.97, 0.53 and 0.7 mg MDA/kg, respectively before storage to 0.78, 0.9 and 0.65 mg MDA/kg (dry weight basis) after 9 days storage, respectively.
The initial pH values of control, 10% SF and 10% MBP burger samples increased from 8.48, 7.8 and 7.48 to 8.8, 7.8 and 7.48 after 3 months storage at -18 °C. Similarly, pH values of control, 20% SF and 10% MBP fingers samples gradually increased from 6.7, 9.9 and 9.79 to 8.9, 8.7 and 9.79 at the end of 9 days storage.

The microbiological examination of sand smelt fish products indicated that the initial total bacterial counts (TBC) for control, 10% SF and 10% MBP burger samples before storage were found to be 1.81×10^7, 6.24×10^7 and 1.02×10^7 cfu/g, respectively. Also, the initial values of TBC for finger samples were accounted by 4.16×10^7, 13.1×10^7 and 8.88×10^7 cfu/g for control, 20% SF and 10% MBP finger samples, respectively. These values of TBC declined during frozen storage. The results showed that the initial counts of mold and yeast in the different samples of burgers and fingers ranged between 1.04×10^7 to 8.7×10^7 cfu/g at zero time storage and no detection could be found for mold and yeast during frozen storage of the samples.

Sensory evaluation data showed that score values of the quality attributes; color, taste, odor and texture as well as overall acceptability of sand smelt fish burgers and fingers slightly declined during frozen storage. The filling materials SF and MBP used in the production of fish products showed an observed effect in maintaining the sensory qualities of the products for 9 days of frozen storage.

Cooking characteristics data indicated that the filling materials SF and MBP had an improving effect in minimizing the cooking loss of sand smelt fish burgers and fingers. The results showed that cooking loss values increased as the storage time extended.