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Research Article
Impact of Thermal Process on Quality Characteristics of Instant Squid Mix

[1]K. Kumarakuru, [2]P. Vasanthakumari, [3]V. Meyappan and [4]K. Sundar

[1]School of Agriculture, PRIST Deemed University, 613403 Thanjavur, Tamil Nadu, India
[2]Indian Institute of Food Processing Technology, 613005 Thanjavur, Tamil Nadu, India
[3]Department of Biotechnology, Pondicherry University, 605014 Puducherry, India
[4]Department of Microbiology, PRIST Deemed University, Puducherry Campus, 605007 Puducherry, India

Abstract

Background and Objectives: Seafood consist of fin fishes, cephalopods, crustaceans and molluscs are being used as a major bio molecules source from time immemorial. Squid are cephalopods and very popular food in Southeast Asia and Indian countries. Shellfish has gained a major health food for several reasons viz, rich source of easily digestible proteins, therapeutically important polyunsaturated fatty acids, major and micro nutrients. Major objective of the present work was to develop the innovative value added ready to eat mix of squid meat were developed and their nutritive, antioxidant capacity and sensory qualities were characterized. **Materials and Methods:** The impact of drying temperature (T1-60, T2-80 and T3-100°C) was investigated on proximate composition, physicochemical characteristics, antioxidant properties and sensory parameters. **Results:** The results found to be highly significant ($p<0.05$). The high value of protein content was reported T3 and T2 samples. All these drying methods reduced the water content and improved the quantity of major nutrients. Foremost changes were obtained in the lipid and ash content of temperature with instant squid mix. Physico-chemical characteristics including bulk density, water activity, color and pH of both different drying temperature and sundried Instant squid mix differed significantly ($p<0.05$). *In vitro* antioxidant activity was analyzed and compared with synthetic antioxidants (BHA). The DPPH and superoxide radical scavenging activity (SRSA) of Instant squid mix ranged from 54.8-60.4 mg mL^{-1} and SRSA range from 50.7-63.1 (mg mL^{-1}) respectively. **Conclusion:** Overall acceptability of the developed instant squid mix from different drying temperature significantly higher than the sundried Instant squid mix. This squid mix was used as instant idli powder in food product industries.

Key words: Proximate composition, water holding capacity, free fatty acids and antioxidant properties, food product, temperature

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Corresponding Author: K. Sundar, Department of Microbiology, PRIST Deemed University, Puducherry Campus, 605007 Puducherry, India
Tel: + 91 8825792882

Competing Interest: The authors have declared that no competing interest exists.

Data Availability: All relevant data are within the paper and its supporting information files.

INTRODUCTION

Seafood's refer to a variety of groups of biologically divergent animals consisting not only of fish, but also of shellfish which include crustaceans and mollusks[1]. Presently, fish has gained importance as a health food for several reasons viz., rich source of easily digestible proteins, therapeutically important polyunsaturated fatty acids, vitamins, minerals such as calcium, iodine and many other micro nutrients. It is indisputable that fish is in all respects a healthy and animal food for consumption of human beings[2]. The demand for seafood is being improved due to the increase in consumption rate by the increasing world population and awareness on the nutritional qualities of fishery resources[3]. Food eating practice of the people is altering very rapid mostly in modern times due to their socio-economic development, accessibility of new resources as food application of enriched, ready foods for the convenience of the customers. Development of novel products from new sources becomes crucial to catch the flavor of various people with diverse food habits. Value addition and diversification of processed seafood is a significant need in fish processing. Value addition refers "any supplementary substances that changes the nature and appearance of the product thus adding value to it for sale". Present market movements are indicative of large growth in require for ready-to-cook or ready-to-eat expediency products processed out of a different of fin and shell fishes. The technology for ready to eat food products preparation is now quickly advancing in south Asian countries. Huge quantity of value added and diversified goods used for export and internal market based on sea foods, bivalves and minced meat from less priced as well as farmed fishes[4]. Many ready to eat or ready to serve products such as soup powder[5], chutney powder[6] are prepared from seafood's. Value can be added to fish and fishery products according to the necessity of different markets and products range from ready-to-cook and eat type products.

Squid is a very popular food in Southeast Asia and India which contains major and micro nutrients such as vitamin B2, vitamin B12 as especially one of the nutrients which have shown to lower homocysteine levels in the body (riboflavin)[7]. Processing is a way of preserving of seafood and improving their quality and increases the shelf life of product by inactivating pathogenic microorganisms and also enhances its flavor and taste. Some methods such as salting and drying have been used in ancient times, long before modern technology was introduced to drying methods to preservation of sea foods[8]. Drying is a method of food preservation that works by removing water from the food, which inhibits the growth of microorganisms and hinders quality decay. Drying food using sun and wind to prevent spoilage has been practiced since ancient times. Water is usually removed by evaporation (air drying, sun drying, smoking or wind drying). The drying behavior of fish (Indian minor carp) has been studied under open sun drying (OSD). The drying rate curves contained no constant rate period and showed a linear falling rate throughout the drying process. Sun drying is the traditional method for reducing the moisture content (MC). Hot air ovens are electrical devices used in sterilization. The oven uses dry heat to sterilize articles. Generally, they can be operated from 50-300°C (122-572°F)[9]. The major objectives of present study to developed the nutritional sea food ready to eat product. This product forms an important and new value added product came after the process of proper dehydration, which can be used as toppings on a variety of masala and idli instant mix powder. The study also extends to find out the nutritional composition of the value added product and evaluation of quality characteristics of Instant squid (*Loligo duvauceli*) powder.

MATERIALS AND METHODS

Study area: The present work was conducted in school of Agriculture at PRIST Deemed to be University, Thanjavur, Tamil Nadu, India in the month of February to June, 2019.

Sample preparation and development process: Indian squid (n = 20) were procured from the fish market in Puducherry, India. Small size squid about 21-3/4 pounds and 9 and 13 inches long fish was selected for the preparation of squid powder respectively. Squid samples were washed with distilled water, dark muscle eviscerated and filleted. The filleted samples were proceeded to dehydration namely sun drying for a period of 36 h and hot air oven drying at varying temperature such as 60°C-T1 (6 h), 80°C-T2 (4 h) and 100°C-T3 (2 h). The dehydrated squid was ground to fine powder by using in a food blender (HR1363 600-W Hand Blender, Bangalore, India).

Formulation of ready to eat instant squid mix (ISM): ISM was prepared by the method described by Bamidele *et al.*[10]. Traditional method of preparation instant powder and their ingredients used in the preparation powder such as roasted Bengal gram dhal, dried chilies, pepper, cumin seeds, salt and oil were used in there preparation of ready to eat ISM. The entire above mentioned ingredient were sautéed in oil and added to the squid powder and further ground to fine powder.

The instant powder was then packed in LDPE (Low density poly ethylene) cover and kept in an airtight plastic container. The samples were labeled according to drying temperature and methods. The proximate composition, physicochemical measurements and antioxidant activity were determined for the instant squid powder mix by AOAC[11] method.

Proximate analysis: Proximate compositions (ash, fat, protein and moisture contents) of ISM were analyzed according to AOAC[11] standard procedures.

Physicochemical measurements

Bulk density: Bulk density was estimated using the gravimetric method as described by Onayemi and Potter[12]. The bulk density of ISM was analyzed by recording the volume occupied by ISM in a pre-weighed 10 mL graduated cylinder up to the 10 mL mark. During ISM filling, the cylinder was tapped 20 times and was weighed again and the bulk density of ISM is expressed as kg m^{-3}.

Water activity and pH: The water activity (aw) of samples was analyzed using a water activity meter (Aqualab Series 4TE, Decagon Devices, Inc., USA). Measurement of water activity was performed until the value was concurrent. The pH value of ISM was analyzed using a digital pH meter (Metrohm AG, Switzerland). About 1 g of sample was mixed with 10 mL distilled water. The pH electrode was inserted directly into dissolved samples according to the method of Manthey *et al.*[13].

Free fatty acids: The free fatty acids of samples were analyzed according to Lowry and Tinsley[14], in the fat extracted by the Bligh and Dyer[15] method (Fig. 1). Toluene (2.5 mL) was used as the solvent of option; 0.5 mL of 5% cupric acetate-pyridine reagent was added to the tube and shaken for 2 min. The biphasic system was centrifuged for 10 min and the top layer was read at 725 nm. A standard curve, using oleic acid solution, was used to calculate the content of free fatty acid in the fat from the sample.

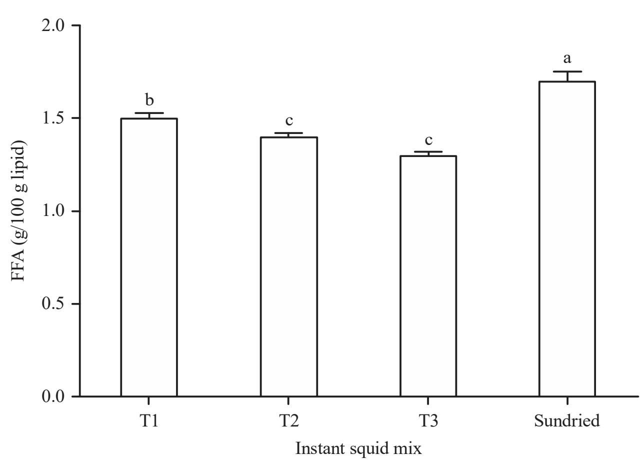

Fig. 1: Free fatty acid of Instant squid mix

Water holding capacity: Water holding capacity (WHC) of ISM was analyzed according to the procedure explained by Chiavaro *et al.*[16]. Sample (~3.0 g) obtained from the dorsal part of the fillet was covered by filter paper and centrifuged at 3000 rpm for 15 min at 25°C. The supernatant was discarded and the sample was reweighed. The fraction of water reserved by the sample after centrifugation was expressed as WHC.

Color analysis: The color of ISM was read as L*, a* and b* using Lab Colorimeter (D-25, Hunter Associated Laboratory, USA) with slight modification by Reddy *et al.*[17]. The chroma (C*) and hue angle (H°) values of samples were calculated by the following equation, respectively:

$$C^* = (a^{*2}+b^{*2})^{1/2}$$

$$H^\circ = \tan^{-1}(b^*/a^*)$$

Antioxidant properties

DPPH: DPPH radical scavenging activity of the ISM was analyzed following the procedure of Klompong *et al.*[18] with slight modification. Instant squid mix was dissolved in 100 mM phosphate buffer (0.25% concentration). About 1 mL of ISM solution 0.2 mM DPPH in 96% ethanol and without disturbance to stand at room temperature for 30 min in dark room and absorbance was read at 517 nm:

$$\text{DPPH }(\%) = \frac{\text{Control} - \text{Sample}}{\text{Control}} \times 100$$

Reducing power assay: The reducing power ability ISM evaluated using the technique described by Beauchamp and Fridovich[19]. Antioxidant properties of ISM were evaluated in other terms as reducing power (RP) through following *in vitro* methods. Samples were taken in different vials and were dissolved in 1 mL of distilled water. Hundred microliter of sodium phosphate buffer (100 mM, pH 7.2) and 100 µL of potassium hexacyanoferrate (III) (1%) were added to each sterile vial and incubated at shaking water bath at 50°C for 30 min. After incubation 100 µL of TCA (10% w/v) was mixed to each sterile vial and centrifuged at 3000 rpm for 15 min. Hundred microliter milliliter of the upper layer was added with 100 μL mL^{-1} of sterile deionized water and 10 μL of ferric chloride (1%). The color developed was read at 700 nm absorbance.

Superoxide radical scavenging capacity: The superoxide radical scavenging capacity was determined based on the factor of the sample to inhibit the photo-chemical reduction of nitroblue tetrazolium (NBT) in the riboflavin light NBT system. The procedure used by Martinez *et al.*[20] for determination of antioxidant activity was followed after necessary modification. Each 1 mL aliquots contained 0.05 M phosphate buffer, pH 7.8, 0.013 M methionine, 0.5 mM riboflavin, 0.1 M EDTA, NBT (0.001 M) and 100 μL instant squid mix solution. The development of blue formazan was followed by monitoring the increase in absorbance at 560 nm after a 10 min illumination from a fluorescent lamp. The entire assay reaction assembly was placed in a box lined with aluminum foil. Identical tubes with reaction mixture were kept in the dark and served as blanks.

Sensory analysis: Sensory evaluation is defined as specific discipline used to evoke, measure, analyze and interpret the characteristics of food and materials as they are perceived by the senses of sight, smell, taste, touch and hearing. The primary function of sensory testing is conducted valid and reliable tests to provide data on which sound decision may be made Meilgaard *et al.*[21]. Thirty PG students of the department were requested to take up threshold sensitivity test using salt, sweet, sour and bitter. As suggested by Meilgaard *et al.*[21] they were mixed in the different composition with the code numbers and the subjects were asked to identify the sequence of the concentration from low to high. Essentially the threshold test determines the sensitivity of the panelist to a particular test. Out of 30 students 15 students were selected for sensory evaluation of the product. The 9 point hedonic score card was used.

Statistical analysis: In this study, all assays were performed in triplicate. The resulting data are expressed as mean with standard deviation. The variance between the mean values was considered significant at $p<0.05$. The data were analyzed using SPSS 21.0 (SPSS Inc. Chicago, USA).

RESULTS AND DISCUSSION

Proximate composition: The proximate composition of T1, T2, T3 and sundried samples were reported. The proximate composition, including moisture, protein, ash and lipid contents, of instant powder mix, showed a significance difference in Table 1 ($p<0.05$). From the findings, there was a decrease from 5.6-4.5% in the moisture content of Instant squid mix using various temperatures and drying methods. Minimum moisture loss was observed for T3, whereas maximum moisture loss was noted for T1 and sundried samples. Decrease in moisture content of samples may be associated to the applied temperature which can denature protein structure (disturbing the protein's ability to bond with water). Further, different temperatures can evaporate muscle water at different levels. The ash content of T2 was the highest, followed by T3 and the lowest values ($p<0.05$) were noted for T1 and sundried. Protein content increased irrespective of the drying method, higher protein content was noted for T2 samples and followed by T1, T3 whereas the lowest value was observed for Sundried. A similar tendency was also noted for the lipid content, which augmented from 3.7% (sundried) to 4.1% (T2). The increase of lipid may be attributed to oil absorption during the instant mix powder process; heat treatment, oil penetration is prominent after the partial loss of water through evaporation[22]. The substantial increase in ash, protein and lipid contents in differently drying samples were correlated with the decrease in moisture content[23].

Table 1: Proximate composition of Instant squid mix

	Chemical composition (%)			
Samples	Moisture	Proteins	Ash	Lipids
T1	4.96 ± 0.09^{b}	75.27 ± 0.12^{c}	3.81 ± 0.05^{c}	4.12 ± 0.04^{b}
T2	4.51 ± 0.07^{c}	70.31 ± 0.05^{a}	4.13 ± 0.10^{a}	4.18 ± 0.03^{a}
T3	4.32 ± 0.04^{d}	78.92 ± 0.10^{b}	3.92 ± 0.03^{b}	4.16 ± 0.02^{a}
Sundried	5.65 ± 0.05^{a}	65.72 ± 0.02^{d}	3.42 ± 0.02^{d}	3.75 ± 0.15^{c}

Values were Means±SD of triplicates, values with the same superscripts in a column did not differ significantly ($p<0.05$) by DMRT, T1: 60°C, T2: -80°C, T3: 100°C

Physicochemical measurements

Bulk density: Commonly, bulk density is used to analyze the sample mass, handling requisite and the type of packaging materials suitable for the storage and transportation of food materials. Also, bulk density indicates the behavior of product and the influence of numerous factors including the preparation method, drying procedure, fineness of particles and moisture content[24]. T1, T2, T3 and sundried had varying bulk densities of 328.3, 318.2, 319.8 and 379.6 kg m^{-3}, respectively, with a significant difference ($p<0.05$). The variance in the bulk density of ISM is possible because the bulk density is mainly influenced by the structure of proteins. Furthermore, the bulk density of ISM is influenced by the hydrophobicity, solubility and hydrodynamic properties of proteins[25]. High bulk density is undesirable for the formulation of ready to eat foods, which are required to be of low density.

Table 2: Physicochemical properties of instant squid mix

	ISM			
Parameters	T1	T2	T3	Sundried
Bulk density (kg m^{-3})	328.30 ± 3.16^b	318.20 ± 5.02^c	319.30 ± 8.02^c	379.60 ± 4.72^a
pH	5.62 ± 0.02^b	5.52 ± 0.05^c	5.22 ± 0.15^d	5.86 ± 0.08^a
Water activity	0.423 ± 0.05^b	0.413 ± 0.02^c	0.405 ± 0.06^d	0.465 ± 0.07^a
Color parameters				
L*	56.40 ± 0.18^a	52.50 ± 0.14^c	50.30 ± 1.66^c	54.20 ± 0.10^b
a*	1.58 ± 0.08^b	1.29 ± 0.05^c	1.38 ± 0.05^d	1.64 ± 0.20^a
b*	20.20 ± 0.19^c	22.40 ± 0.20^b	23.60 ± 0.12^a	19.50 ± 0.05^d
Chromaticity	21.78 ± 0.15^c	23.69 ± 0.08^b	24.98 ± 0.31^a	20.13 ± 0.17^d
Hue angle (°)	85.49 ± 0.12^b	86.75 ± 0.25^a	86.65 ± 0.10^a	85.03 ± 0.18^c
WHC (mL g^{-1})	17.10 ± 0.05^c	17.65 ± 0.09^b	17.84 ± 0.08^a	16.25 ± 0.04^d

Values were Means±SD of triplicates, values with the same superscripts in a column did not differ significantly (p<0.05) by DMRT, T_1: 60°C, T_2: 80°C, T_3: 100°C, ISM: Instant squid mix

Water activity and pH: Water activity (aw) precisely measures the shelf life of any food system. This intrinsic property denotes the availability of free water in the food system. Reduced aw of a food system provides a shield to microbial growth and delays deterioration in the biochemical reaction. By contrast, increased aw decreases the shelf life. In the current study, aw values of differently ISM ranged from 0.40-0.46. The pH value of ISM was summarized in Table 2. The pH value of sundried 5.86. Sundried exhibited higher pH values than T1, T2 and T3. The decrease in pH was not significant among T1 and T2, whereas T3 showed the lowest pH of 5.22. The pH values of ISM play a significant role in determining their shelf life and functional properties

Free fatty acids: The primary and secondary oxidation products have been studied by the complexity of the lipid oxidation process. Free fatty acids amount of ISM was significantly reduced by the different drying temperature determined. The defeat of volatile FFA perhaps occurred during dry heating, leading to a decreased FFA range. Instead, the higher FFA content in sundried when compared to T1, T2 and T3 samples could also be explained by the deactivation of enzymes, due to the drying process. This would prevent the release of free fatty acids due to lipase activity in the direct dried samples. Similar type of finding by Selmi *et al.*[26] shows lipid deterioration took place during sun drying process and generated a moderate increase in the peroxide value and free fatty acids in the final product. We found the lowest FFA values in the T2 and T3 samples.

Water holding capacity: The WHC of T1, T2 and T3 and sundried is shown. From the findings, WHC values of all ISM ranged between 16.25 and 17.84 mL g^{-1}, with a significant difference. T3 had the highest WHC value and the lowest value was observed for sundried. The binding capacity between food materials and water molecules plays a major role in food systems because it improves mouth feel, flavor retention and texture. Additionally, the carbohydrate content greatly influences the WHC of foods.

The WHC of ISM is summarized in Table 2. The WHC of sundried was 16.7%. The WHC of T1, T2 and T3 significantly increased. T3 showed the highest WHC, followed by T2. Drying methods that increase the temperature result in higher WHC. WHC is dependent on a combination of factors, including physical factors such as concentration, temperature gradient and protein denaturation[27]. Protein denaturation results from a change in the internal structure of muscle and capillaries. The lowest WHC was noted for T1. With the increase in temperature in various different temperature and drying methods, heat-induced protein denaturation occurs, aggregating and shrinking the filament lattice and collagen. Such aggregation and shrinkage expose the hydrophobic areas of myofibrillar protein, resulting in a denser structure and water loss[28].

Color analysis: In addition to taste and texture, color parameters are important characteristics that influence the acceptability of food products. Color parameters (L*, a* and b*) of ISM from four samples are presented. Furthermore, these values were used to determine color properties such as chromaticity and the hue angle. T1 had the highest L* value followed by sundried and T2 The lowest L* value was noted for T3. Significant difference between lightness values of ISM due to the different temperature and drying method. T1, T2 and T3 showed significant changes in the b* value when compared with that of sundried. The b* value was the highest for T3 samples. The a* value of differently ISM significantly decreased. This finding may be correlated to protein aggregation, leading to increased opacity, low light transmittance and the formation of colored compounds

Table 3: Antioxidant properties of instant squid mix (mg mL^{-1})

Parameters	T1	T2	T3	Sundried	BHT
DPPH (%)	58.2±0.07[c]	60.4±0.18[b]	60.2±0.05[b]	54.8±0.12[d]	85.7±1.06[a]
RP (700 nm)	0.12±0.01[d]	0.16±0.01[b]	0.14±0.02[c]	0.10±0.02[e]	0.23±0.05[a]
SRSA (%)	55.9±0.17[d]	60.6±0.12[c]	63.1±0.13[b]	50.7±0.36[e]	78.3±0.98[a]

Values were Means±SD of triplicates, values with the same superscripts in a column did not differ significantly (p<0.05) by DMRT, T_1: 60°C, T_2: 80°C, T_3: 100°C, BHT: Butylated hydroxytoluene

Table 4: Sensory characteristics of instant squid mix

Sensory parameters	0-15 days				16-30 days				31-45 days			
	T1	T2	T3	Sundried	T1	T2	T3	Sundried	T1	T2	T3	Sundried
Appearance	7.2	7.8	7.5	6.9	7.2	7.6	7.3	6.8	6.9	7.3	7.2	6.4
Taste	7.0	7.2	7.0	6.8	6.8	7.0	7.0	6.6	6.8	7.2	6.8	6.8
Texture	7.1	7.5	7.2	7.0	6.9	7.4	7.3	7.0	7.0	7.4	7.0	6.5
Flavor	7.5	8.0	7.8	7.0	7.4	8.0	7.4	6.8	7.0	7.5	7.4	6.3
Overall accessibility	7.6	8.1	7.8	7.1	7.6	8.0	7.8	6.9	7.4	7.8	7.4	6.7

Values were average and means of triplicates, T_1: 60°C, T_2: 80°C, T_3: 100°C

involving hydrogen sulfide, which are released from amino acids in the Maillard reaction[29]. Chromaticity was calculated as chroma (C*), which symbolizes the fullness of color. T2 exhibited the maximum chromaticity. The hue angle denotes the sensitivity of color. From the findings, the hue angle (0-90°) of raw and cooked fish fillets was found to lie in the first quadrant, consistent with the sort of reddish-purple to yellow.

Antioxidant properties

DPPH: Scavenging of DPPH radicals mainly involves the single electron transfer mechanism. The assay is rapid and easy and is useful for the fast screening of antioxidant potentials of samples[30]. DPPH radical scavenging activity of ISM at the concentrations (mg mL^{-1}) with compared to stranded range of BHA (Synthetic antioxidant). The activity of all ISM significantly difference (p<0.05). The T2 reported maximum radical scavenging activity 60.4±1.18%, compared to another ISM samples. The results revealed that squid muscles and pulses presence of hydrophobic amino acids exhibited the highest radical scavenging activity. The BHT was significantly (p<0.05) more potent in scavenging DPPH radical when compared to ISM.

Reducing power: To assess the ability of an antioxidant to donate an electron or hydrogen, reducing power assay was used[31]. Antioxidant activity and reducing power are directly correlated. In this assay the reduction of Fe^{3+} to Fe^{2+} by the hydrolysate is assessed; where the Fe^{2+} complex was exhibited by the formation of pearls Prussian blue color which was measured at 700 nm. All the drying method samples showed some degree of electron donation capacity. The reducing power of FPIs was significantly (p<0.05) lesser than that of standard antioxidant (BHT). T2 revealed the potent reducing power (0.16±0.02) followed by T3 (0.14±0.02), T1 (0.12±0.07) and sundried (0.10±0.02) respectively.

Superoxide radical scavenging activity (SRSA): Table 3 illustrates the superoxide radical scavenging activity of T1, T2 and T3 and sundried as compared to BHT respectively. The superoxide radical scavenging activity was dose-dependent manner as observed from inhibition of superoxide radicals with the different drying squid mix powder and BHT as a standard. T3 exhibited the highest radical scavenging activity (63.1%) among the other T1 and T2. Lowest radical scavenging activity was exhibited with sundried (50.7%) maximum absorbance of 560 nm was recorded for superoxide radical scavenging assay respectively, whereas the inhibition by BHT 78.3% mg mL^{-1}, respectively. The effect of increasing the antioxidant potential of ISM was observed from the inhibition of superoxide radicals by the presented of hydrophobic amino acids[32].

Sensory evaluation: Table 4 reported the meteorological data collected during period of storage for 0-45th days and the sensory test was conducted for every 15 days. Overall quality was selected as a criterion to determine the shelf life of the dried Instant squid mix. It was observed that there was a decline in the mean scores which ranged from 7.6-7.4, 8.1-7.8, 7.8-7.4 in the product T1, T2, T3 and 7.1-6.7 for the sundried product in the storage period. The sensory scores were found to be decreased as the storage period increased in ISM. The overall acceptability shows the ISM was most acceptable. From the results it can be concluded that ISM can have good sensory quality for up to 1 month after production and rancid odour or flavor in enriched ISM is probably caused by hydrolytic rancidity or lipid oxidation of squid fish. It is recommended to use the product with in the month of production.

Present study emphasizes the nutritional properties of squid mix including their physicochemical character, proximate analysis and antioxidant ability. The optimum conditions thermal treatment can be applied in the preparation of commercial instant squid mix. Larger scale preparations can use this study as a model system and need to set up the processing technology for instant squid mix.

CONCLUSION

This study provided a detailed report on the proximate, physicochemical, antioxidant properties and sensory evaluation of instant squid mix ready eat product prepared three different drying temperature and sundried methods from Indian squid. ISM is the most refined form of sea food products and contains the highest concentration of protein. The results revealed that T3 and T2 exhibited more favorable physicochemical properties than sundried samples and T1. Moreover, all ISM displayed high WHC, color and low bulk density. Other hand ISM has the potential to scavenge free radicals such as DPPH and superoxide that have been concerned in caustic cellular reactions. Low free fatty acids of instant squid mix prepared through the drying process replicates their sensory and physicochemical properties and their potential role in sea food product or as nutritional assistant to decrease damaging health influence of endogenous lipid peroxides. Therefore, the Instant squid mix can be used as a ready to eat product and also high nutrition sea food and animal proteins from squid muscles.

SIGNIFICANCE STATEMENT

This study discovered the influence of thermal process in the preparation of instant squid mix that can be beneficial for optimizing the methods during its commercialization: this study will help the researchers to uncover the critical areas of in relation to properties of the study product that many researchers were not able to explore. Thus a new theory on thermal treatment may be applied for the preparation of instant squid mix.

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