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Effects of Different Conservation Methods on Minerals Level Sand Nutritional Value of Dried, Salted, Smoked and Sundried Fish

Mpho Sylvia Tsheole* and Keitiretse Molefe

North-West University, Department of Animal Health, Faculty of Natural and Agricultural Science, Mafikeng Campus, South Africa

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***Corresponding author**: Mpho Tsheole, North-West University, Department of Animal Health, Faculty of Natural and Agricultural Science, Mafikeng Campus, South Africa.

Abstract

This study aimed to compare the variability of different drying methods of fish on the mineral and nutritional value of fish. In this research study, we document the effects of different conservation methods on the nutritional and mineral content of dried (smoked, salted, and sundried), which was bought from fish markets in Johannesburg and Pretoria. The aim was to access and know the effect of conservation methods on dried fish to whether they oppose public health risks or not. A total of 74 samples were analyzed for mineral and nutritional contents. Only 37 dried fish samples were analyzed using the Near-infrared spectrometer. The results of this study indicated that sundried had the highest moisture content (196,5) compared to both salted (194.18) and smoked (147,74). This study also revealed that smoked fish (147,74) had lower protein content compared to sundried (1965). For mineral content in smoked fish, Iron was the highest with (94%) followed by sundried (92%) and salted with (85%). In all samples for sundried, smoked, and salted zinc was the lowest in all groups (sundried 3%) (smoked fish (196,5), and (salted 2%). Smoked fish (147,74) had lower protein content compared to sundried (2%) reason being that smoking processes make the fish protein denature fast and reduce the biological availability of protein.

Keywords: Fish; Mineral; Nutrition

Introduction

Salting, sun-drying, and smoking fish are regarded as old traditional methods of preservation of perishable food which are easy to conduct in many countries around the world, they have also should positive outcomes and effects on fish [1]. As stated by Msusa et al. [2] smoking may increase protein retention also know that protein loss and fat are because by additional salt, and high moisture content in tissues can be reduced by smoking fish to increase the shelf-life. According to Msusa et al., [2], a way of obtaining maximum nutritional value and fish with a longer shelf life is by using the smoking method.

Famurewa et al., [3] indicated that minerals such as calcium, zinc, and iron values in catfish that were smoked were slightly higher than one in fresh fish, these results were observed from fish that was cooked in different cooking methods. Their study also showed that frozen storage is associated with dehydration and drip loss which bring changes to mineral contents. Strong preservative properties may be found in salting, but it also has bad reactions or outcomes on nutrient loss, proteins, and fats. Thus, the salting process should be practiced with caution to prevent loss of the most dietary nutrients required [2].

According to Mohan et al., [1] the era we live in is influenced by factors driving the global food industry which are health, nutrition, and convenience with fish having important nutritional components like high- quality protein, essential vitamins, minerals, and healthy polyunsaturated fatty acids for human diets thus makes seafood ranked third among the fastest overall growth food category worldwide next to drinkable yogurt and fresh soup [1]. Fish can be used as an income generator as part of the foreign exchange in harvesting, handling, and processing methods done at the right time after post-harvesting [4].

A study by Abraha et al. [4] reported that the extent of heating and temperature is the dependent factors of several fish processing changes and protein denaturing. Perishable food preservation involves a process that impedes the growth of micro-organisms

after death either by additional growth of inhibiting ingredients or storage adjustment by freezing or drying [5]. Another study by Maulu et al. [6] stated that rural community development programs shows that post-harvesting activities in the fisheries value chain receive less attention despite them being critical components of the livelihood structure. Fish has many health benefits mostly related to heart conditions and diseases, decrease risks of prostate cancer in males and Alzheimer's disease [4].

According to Ayeloja et al. [7] malnutrition in developing countries can be prevented or relieved by using fish as a source of nutrition, as it contributes 60 percent of the total protein intake in adults. Fatty fish has polyunsaturated fatty acids such as EPA (eicosapentaenoic acid) and DHA (docosahexaenoic acid) omega 3 fatty acid which are good to prevent cardiovascular disease such as coronary heart disease and promote proper growth in children [4]. A study by Djopnang et al. [8] reported that freshwater fish (*Chrysichthys nigrodigitatus*) fatty acids are important for brain, eye development and good cardiovascular health.

As many societies in developing countries are suffering from hunger and malnutrition, fish plays a major role in the diet of the population in West Africa [9]. Another study also indicated that fish production, processing and trade contributed towards 200 million Africans in 2004 to the food and nutritional security [10]. According to Bennett et al. [11] cognitive development, alleviate stunting, improvement of maternal and childhood health, strengthening of the immune system and reduction cardiovascular diseases can be supported by fish which is some animal source rich in micronutrients, essential fatty acids, and animal protein. Thus, fish is playing a significant role in food and nutrition security globally. For fish to be used as a source its nutritional value is obtained from its chemical composition, which differs from species to species and with the same type of species [4]. Research has shown that 70-84 percent of fish composition is water with 15-24 percent protein, 0.1-22 percent is fat, 1-2 percent be minerals and 0.1-1 percent be carbohydrates [4]. There are main factors which determines the chemical composition of fish which are sex, feeding habit and seasonal variations thus this knowledge is vital to develop processing technology for fish and its products for commercial and industrial level [4].

It has been shown that to increase the shelf-life of the fish, different preservation and processing methods are used to slow down the spoilage rate in fish [7]. Additionally, to appease the consumers to buy yellow croaker, the odour and flavor can be used as determining factors as people buy fried fish according to how it smells and tastes [7]. To improve the shelf-life of the fish, to keep it longer, avoid post-harvesting losses and to preserve its taste, flavour and texture can be conserved by either smoking, sun-drying, canning, cooking and salting [9].

According to Mohan et al., [1], raw food is converted into edible, usable and palatable food also helps agricultural commodities in preservation and storage of perishable and semi-perishable food. Furthermore, this saves people time to cook as products develop into ready-to-consume convenient products thus help in inhibiting anti-nutritional factors, adds value by improvement in palatability and organoleptic quality of the produce [1]. These researchers further indicated that marketing and distribution tasks are eased, thus helping in avoiding glut in the market and reduction of post- harvesting losses are attained also generates income or employment. After few hours of death fish suffers rigor mortis as part of spoilage, breakdown of components in the fish body leads to recreation of new components which promotes spoilage, oxidation of lipids and protein denaturing [12]. Those researchers also indicated that fish spoilage is a process that arises from actions of enzymes, bacteria and chemical constituents and has three steps which are Enzymatic autolysis, Oxidation and Microbial growth.

Getu et al., [12] 's research also indicated that enzymatic breakdown of major fish molecules in dead fish after capture causes chemical and biological changes, texture quality is reduced at the early stages of deterioration but does not affect spoilage characteristics (off-odour and off-flavors). Additionally, that shelf-life of fish and quality are limited by autolytic degradation which can also happen in chilled or frozen fish [12]. Meat softening, rupture of belly walls and blood water drainage which contains proteins and oil because of extensive autolysis caused by digestive enzymes [12]. Post- mortem degradation in fish muscles and fish products at storage and processing is influenced by proteolytic enzymes found in muscles and viscera, process of solubilization follows proteolysis which is responsible for protein degradation during improper storage [12]. The authors also indicated that major cause of deterioration and oxidative spoilage for pelagic fish species is lipids spoilage which involves three stages: initiation which involves radical formation of free lipids through heat, metal ions and irradiation and they react with oxygen and form peroxyl radicals; hydroperoxides and new free radical are formed from reaction of lipids molecules with radical peroxyl, this is all during propagation. Additionally, termination occurs because of build-up of free radical interact forming non radical products, oxygen reacts with the double bond of fatty acids this makes fish with polyunsaturated fatty acids highly susceptible to oxidation [12]. Lipolysis cause formation of free fatty acids which causes bad flavor and reduction of oil quality because glycerides are dived by lipases and lipolytic enzymes are either endogenous of food product or derived from psychotropic microorganisms, lipases are found in the skin, blood and tissues [12]. The water in which fish live has microbial contents which determines the composition of microflora therefore amines, biogenic amines such as putrescine, histamine, and cadaverine, organic acids, sulphide, alcohols, aldehydes and ketones with unpalatable and inappropriate flavors are produced by microbial growth and metabolism [12].

A study by Getu et al., [12] revealed that chilled fish can be spoiled by psychrotolerant gram negative bacteria such as Pseudomonas spp. and Shewanella spp. spoil, the gram-negative fer-

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mentative bacteria such as Vibrionaceae spoil unpreserved fish and not all bacteria found in fish spoil it. Fish spoilage is a result of microbial deterioration which is determined by trimethylamine levels, trimethylamine oxide is used as an osmoregulatory by fish to avoid dehydration in seas or oceans and tissue in waterlogging in fresh water and Shewanella putrifaciens, Aeromonas ssp. Psychrotolerant Enterobacteriaceae and Vibrio ssp. reduce trimethylamine oxide to trimethylamine by stealing oxygen from it to create ammonia like flavors [12].

The pH value is the key indicator of how the microbial spoilage has extended in fish during storage. It decreases also reliable for indicating freshness spoilage degree [3]. Acids fermented by carbohydrates in fish decrease the pH levels thus by observing the pH levels in smoked-dried fish species like Bony Tongue, H. niloticus, O. niloticus snake fish, and African carp which were stored for 8 weeks at an ambient temperature, storing smoked fish is way better than freezing fresh fish as it has a tendency of getting spoiled faster [3]. To preserve fish quality and quantities to keep them in a good state to use for off seasons throughout the year it is essential to process in the right way at the right time [4].

Additionally, processing methods have different applications, techniques and their own significant influence on the chemical, physical and nutritional composition of processed fish, thus different quality could be obtained through these methods which influence fish's shelf-life variations [4]. Water is the main component of fish flesh which is about 80 percent of the weight of fresh fish with moisture as about 70 percent of the fatty fish, protein cannot be rapidly expelled even under high pressure because its tightly bound to the muscles in the structure (Pal et al., 2018). According to Venugopal (1995) total protein requirement is accounted for by the 14 percent which is provided by fish and shellfish which is needed by the world need for animal protein.

With fish as a good source of high-quality protein particularly for essential amino acids lysine and methionine its 85-95 percent is excellent digestible fish proteins and amino acid composition (Pal et al., 2018). Seawater minerals are best acquired from fish which has the value range from 0.4 to 15 percent which are high bioavailable minerals: zinc, iron, phosphorus, selenium fluorine and iodine (Pal et al., 2018). According to (Pal et al., 2018) important element for hormones thyroxin that regulates body metabolism and required for growth and mental development in children is iodine, selenium is good for trace element of antioxidant, iron required in transporting oxygen to all body parts regulated by synthesis of hemoglobin in red blood cells. Calcium, phosphorus, and fluorine intake is higher when small fish is consumed with bones with calcium important for strong bone formation and mineralization, and normal functioning of the muscles and nervous system (Pal et al., 2018).

They are necessary for good human health however there is a significant correlation between higher fish intake and lower intake and lower risk of hip fracture found in Chinese elderly (Fan et al., 2013). Norman (2008) found vitamin D to receptor either present or involved in many other body systems such as the adaptive and innate immune system, pancreas, and brain. According to Tilamia and Samples [13] fish produce

vitamin D_3 form of vitamin D which was recently found to be more than 3 times higher potency compared to vitamin D_2. According to (Pal et al., 2018) bone formation and teeth, cell building, prevention of poor eyesight, normal growth and assistance in the treatment of eye diseases are elements of vitamin A, vitamin D works hand in hand with strong bones together with vitamin A and C to help prevent cold.

The chemical structure is used to classify fatty acids into three groups: saturated mainly found in animal food such as (cheese, meat, sausage), mono-unsaturated found in fatty fish and poly-unsaturated fatty acids found in are found in two groups omega-3-fatty and omega-6-fatty acids (Pal et al., 2018). According to Pal et al. (2018) there are insoluble lipids which are soluble in water in organic solvents such as chloroform, ether or benzene and contain long-chain hydrocarbon groups in their molecules. The barrier of separation of living cells from outside and the major source of cellular energy and function in living organisms where they can be stored is formed by animal structural compound and plant integrity (Pal et al., 2018). Additionally, the usual range of fats is 0.2 to 25 percent. As water level falls the fat content rises this differ from other lipids in that they longer-chain fatty acids and a larger proportion of highly fatty acids (Pal et al., 2018).

According to Deng et al. (2011) proteins are an expensive component of fish feed but also a major concern during feed formulation which contributes to the growth performance of cultured species. These are linkage of individual amino acids by peptide bonds, examples of essential amino acids are arginine, valine, histidine, isoleusine, leucine, lysine, methionine, threonine, tryptophan and phenylalanine important in the dietary proteins [14]. According to Craig et al. [15] different kinds of fish require different protein levels for example Shrimps needs 28 to 32 percent, Catfish needs 35 to 40 percent and Tilapia 35 to 40 percent and it is typically lower for herbivorous fish (plant-eating) and omnivorous fish than for carnivorous fish.

Another study by Volkoff and London [16] reported that dietary lipids such as triglycerides are important because fish gets essential fatty acids from them since cannot synthesis some essential fatty acids also, they provide high energy for fish, essential to maintain structural and cellular function, however, excess dietary has been reported to cause inadequate protein intake and suppress growth. Low levels of lipids and fatty acids have negative effects on reproduction for larval survival in fish such as carp, since lipids are transferred to ovaries from muscles and liver during gametogenesis [16].

These are the least expensive sources of energy for a fish diet that are not essential but are used to avoid high feed costs in aquaculture and for binding activity during feed manufacturing [14].

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Furthermore, Robert (1979) said that various ranges of carbohydrates are used to prepare floating feeds for finfish. When sugar becomes larger and more complex it rapidly decreases digestibility since fish have the capability to digest simple sugars efficiently [14]. Normal fish growth and health are supported by vitamins, and they must be provided in feed though they are not synthesized by fish [15].

Those researchers also indicated that only vitamin C used to enhance the immune system of fish and shrimp is the most powerful one out of all the types of water-soluble vitamins which includes B vitamins (thiamine, riboflavin, and niacin), inositol, choline, and vitamin C (ascorbic acid) with vitamin E which is important as an antioxidant and vitamin C of the fat-soluble category also inhibits the dietary lipid oxidation to improve shelf life [15]. These inorganic elements in diet grouped in microminerals (sodium, chloride, potassium, and phosphorus) to aid in bone formation, regulation of osmotic balance and integrity and the ones which are required for components in enzymes and hormone systems in small amounts are microminerals (iron, copper, iodine, chromium, zinc, and selenium) [16]. Additionally, fish use their gills and skin to absorb minerals directly from the water to compensate to some extent for mineral deficiencies in their diets.

Research has indicated that insect infestation poses a major problem in the fish industry as the smell of fish attracts lots of insects during sun drying fish should be carefully monitored, insects should be chased away as they lay eggs on fish and cause contamination of insecticides used to keep them away from fish for example salted Irish and smoked Metapenaeus have once been victim of insect infestation, they were eaten by insects causing qualitative and quantitative losses as they were not handled accordingly when raw [15].

Those authors also reported that some developing countries have a serious blowfly infestation problem which is also linked to improper and harmful insecticides by fish processors as they once applied them directly to their fish placing their health and consumers in great danger. Fish is exposed to blowflies' post- harvesting to storage which lay eggs that develop into larvae and produce maggots on the fish bodies, this means proper hygiene steps should be followed but on small scales, they are either avoided or not done properly [15].

In Siavonga district, Southern Zambia quick selling while fish is still fresh, agriculture production employed quick processing or preservation were employed as a way of minimizing post-harvest losses of fish in the artisanal fishery, commercial fishery and aquaculture production with quick sell while fresh being the most effective strategy [6]. Moreover, improvement in post-harvesting practices is very crucial and the increase in supply and demand of fish.

Maulu et al. [6] preservation or processing methods are done by artisanal fisheries, commercial fisheries and aquaculture producers in the Siavonga district with common ones being smoking, chilling, sun-drying, and freezing as an alternative. This study also indicated that the effectiveness varies from one category to another as artisanal fisheries rates methods as 83.67 percent effective while 16.33 percent is very effective, commercial fisheries showed that 84.75 percent effective practices with 15.25 percent very effective practice rated and aquaculture producers rated practices 92.21 percent very effective and only

7.69 percent rates them effective [6].

Smoking fish is a way of decreasing water levels and kill microbes which makes the fish to become rotten [6]. Based on the study of Abraha et al. [4], there are two types of smoking (cold and hot smoking), hot smoking process involves usage of heat, formaldehyde and phenols found in the smokes which acts as preservatives or anti-microorganism. Studies done by Famurewa et al. [3] shows that during this process fish dries out less moist areas for bacteria to grow are created or left, the carcinogenic

effect of the woods opposes health risk for human beings if the right procedures to choose the correct woods and consideration of chemicals are not followed. For cold smoking fish is first fermented, salted or cured before is preserved. Soluble proteins and amino acids are always reduced because of traditional smoking and influence increase in insoluble protein [4].

According to Djopnang et al. [8] the amount of saturated fatty acids like lauric, tridecanoic, myristic, palmitic, heptadecanoic, and stearic acids are increased while amounts of unsaturated ones like n-3 and n- 6 polyunsaturated fatty acids by smoking effects which can be associated with fay oxidation thus decreases levels of essential fatty acids in the diet.

According to Abraha et al. [4] sun-drying is the fastest and less expensive conservation method at the same time it has its own advantages and disadvantages for example the outer layer dries out fast and traps moisture inside the fish which makes proteins to degrade as the drying process has become slow. The longer you keep your fish under the sun for drying it increases health risk for people consuming as its lipids oxidize. Fish attracts mosquitoes and insects so when sun drying a covering netting material should be used to keep them away to avoid contamination [4]. According to Msusa et al. [3] sun drying has average nutrient quality.

Salting is a way of preserving fish using salt by preparing a brine containing a 5% concentration of sodium chloride and dipping fish for 30 minutes this is believed to cause an increase in fish moisture due to the hydroscopic action of sodium chloride [3]. The osmosis effect plays a role whereby in highly concentrated salt brine fish tissues will allow high levels of water to pass from tissues to the brine until strength of both the salted brine and the salt concentration on the fish tissue is equal at the same time salt penetrates the tissues. Salting always alters levels of protein and fat composition in fish [5].

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Dried fish areas are found to be unhygienic with no way to protect it from flies [17]. Moreover, Fish there is always attacked by blowfly and housefly which they suggest that salting before drying prevents insect infestation. Fish is exposed to blowflies post-harvesting to storage which lay eggs that develop into larvae and produce maggots on the fish bodies, this means proper hygiene steps should be followed but in small scales, they are either avoided or not done properly [17].

In Ethiopia fish marketing is influenced by poor transportation and preservation facilities thus is why there is an ineffective marketing network which is substantial potential for fish marketing [18]. The study also stated that lake Hawassa has major marketing problems influenced by it lacks proper processing and storage facilities, lack of transportation, lack of permanent fish marketplace and lack of a wariness.

Lake Abaya and Gidabo river fishery production systems have a serious transport problem and other necessary infrastructure showed during system [10]. Motorcycles, donkey back are forced to be used as transport by fishermen since there are no transport, fishermen sell their dried fish at Gololcha or Dilla to fish traders, consumers, or hotel owners at a very low price [18].

Traditional gear that particularly accounts for most of the fisheries in Rivers due to lack of access to fishing equipment, it's not easy to get material like motors for boats, different sizes of net in all fish production potential areas [18]. Lack of permanent fish marketplaces, absences of efficient fishing equipment, lack of basic infrastructure, lack of training and extension services are the main reasons for the underutilization of fishery resources from the existing potential in most water bodies [18].

Therefore, further studies should be done to identify whether dried, salted, and smoked fish influences different conservation methods on minerals and nutritional value of dried fish focusing on micro minerals such as chromium, iodine, and manganese.

Materials and Methods

Study area

The samples for this research were obtained from Johannesburg and Pretoria central business district in Gauteng province. (Figure 1)

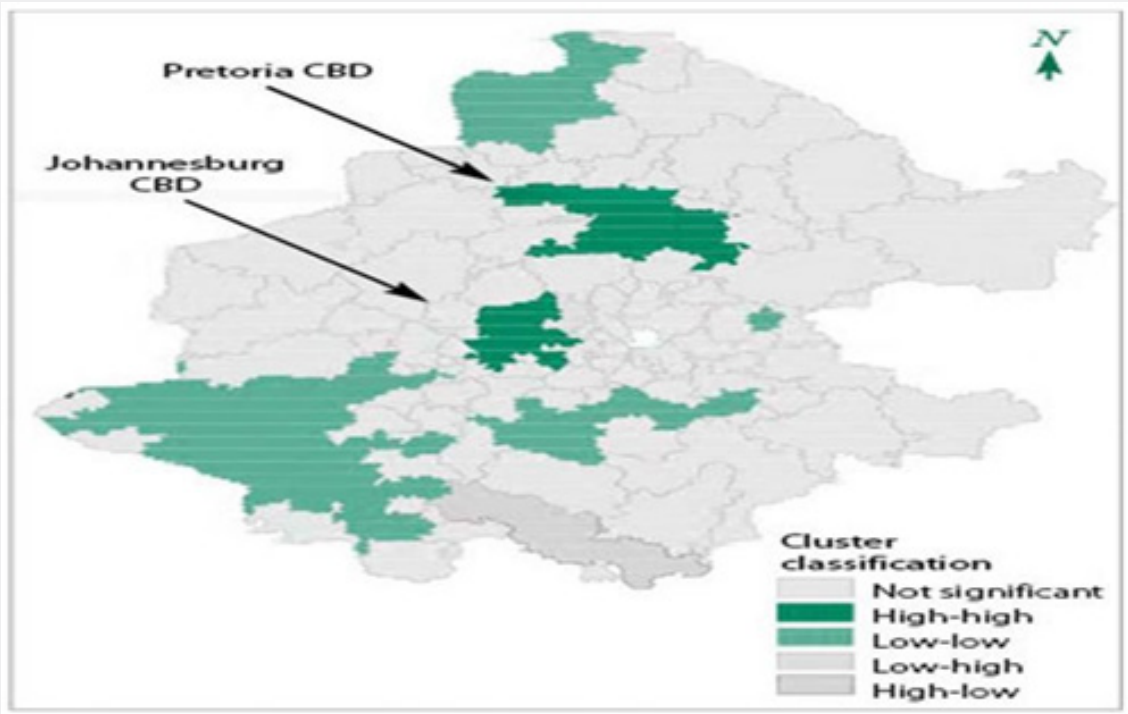

Figure 1: Map of Johannesburg and Pretoria CBD sourced from SciELO SA

Study population

Fish samples used for this research study were bought randomly from different shops in the fish from Johannesburg and Pretoria CBDs.

Sampling procedure

Fish samples were bought, placed in plastic bags and preserved on ice and transported to Northwest University Mafikeng Campus, Animal health department laboratory. The samples were

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then stored in refrigerator at -6 degrees until analyses.

Digestion for sundried, smoked and slated fish samples

One gram of dried fish samples was weighed using linear scale. The sample was dried on an oven at the temperature of 106 degrees Celsius for overnight. The samples were removed after 12 hours and allowed to cool in the desiccator. Then the fish samples were placed in the furnace at 16h00 in the afternoon for ashing, samples were ashed at the temperature of 108. The sample was removed after 16 hours and placed in the desiccator for cooling. The samples were then weighed using linear scale and dried weights were recorded Tsheole and Mwanza [19].

Sample collection or Data collection

Thirty-seven samples of fish

were bought from the Johannesburg and Pretoria CBD informal market. Fish was preserved to avoid spoilage after it has been harvested from the sea and transported to the markets where it was sold to the public or consumers and to decrease and limit the oxidation, enzymatic autolysis, and denaturing of protein which may lead to food poisoning.

Sample analysis Sample preparation Nutrition analysis

For nutritional content sample was analysed using (NIRs) Near Infrared Reflectance spectrometer (model 2500XL-1, Unity Scientific),100ml of dried fish sample was transferred into the spectrometer spout sample cup (Black Pos.) then placed on the spectrometer for analysis. The results were read within 60 seconds.

Mineral analysis

The fish samples were analysed as follows: by adding 9 ml of HCI acid and 3 ml nitric acid to the sample in a crucible. Sample transferred from crucible to a 100 ml volumetric flask, samples were then topped up with distilled water to make up 100 ml sample. The samples were then left overnight on the bench for sediment to settle down. The following day samples were filtered using Whatman qualitative filter papers

to transfer 10 ml of each sample into a 15 ml centrifuge tube. Then the samples were later analysed for zinc (Zn), copper (Cu), iron (Fe), iodine (I), chromium (Cr), Manganese (Mn) and selenium (Se) using the ICP- Mass Spectrophotometer model 2020 from Perkin Elmer according to Tsheole and Mwanza [19].

Data analysis

The data collected was analysed using the Statistical Package for Social Sciences (SPSS 2021) version 26. Descriptive statistics were used to show the variation in the different nutrient and mineral contents in smoked, salted and sundried fish.

Results

(Table 1)

Table 1: Near Infrared Reflectance results for nutritional contents.

	Mean Concentrations in Different Fish		
	Salted	Smoked	Sundried
Moisture	194,18	147,74	196,5
Oil A	36,56	151,33	129,5
OilB	71,61	166,8	164,82
Protein	332,97	605,21	1063,1
Fiber	-18,04	-5,83	-11,04
Ash	366,03	248,92	485,88

Mean concentration in different preserved fish samples is shown in Table 1 acquired from the Near Infrared Reflectance spectrometer.

(Figure2)

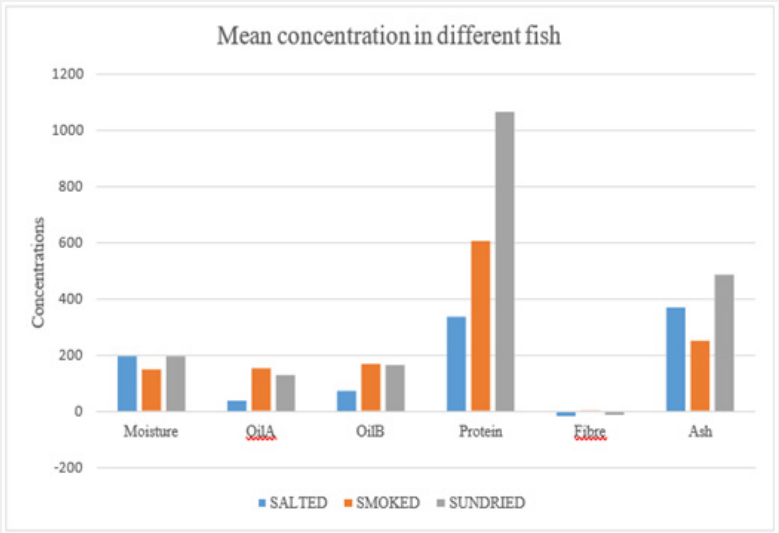

Figure 2: Mean concentration in the different fish.

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Shows mean concentration in different conserved fish samples.

(Figure3)

Figure 4 shows that fish which was dried by smoking had less fiber content of 0% and was more concentrated with protein content of 46%.

Figure 5 shows that sundried fish had high protein content of 52% and Ash content of 24% with low fibre of -2% and both oil A (6%) and B (8%) were almost the same content values

Analysis of Minerals contents

For mineral contents analyses, I weighed 1 gram of each sample into the crucible which was dried overnight using the furnace burner and placed using the tong to avoid contamination, in the morning I used the tong to remove them then used a measuring cylinder to measure to measure 9ml of chloride acid and 4 ml of nitric acid which

Figure 6

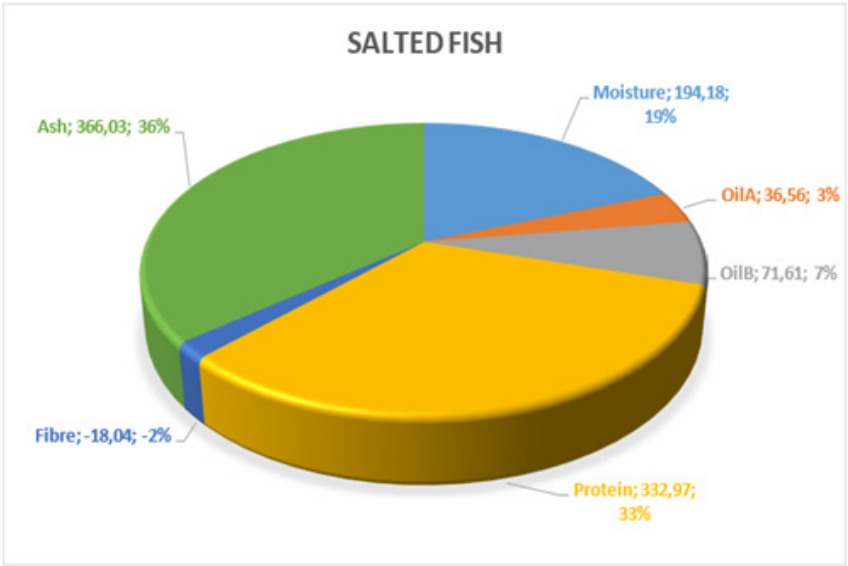

Figure 3: Nutritional content values for salted fish Salted dried fish had high Ash content of 33%, protein content of 36% and lowest fibre content with -2% as shown in figure A.

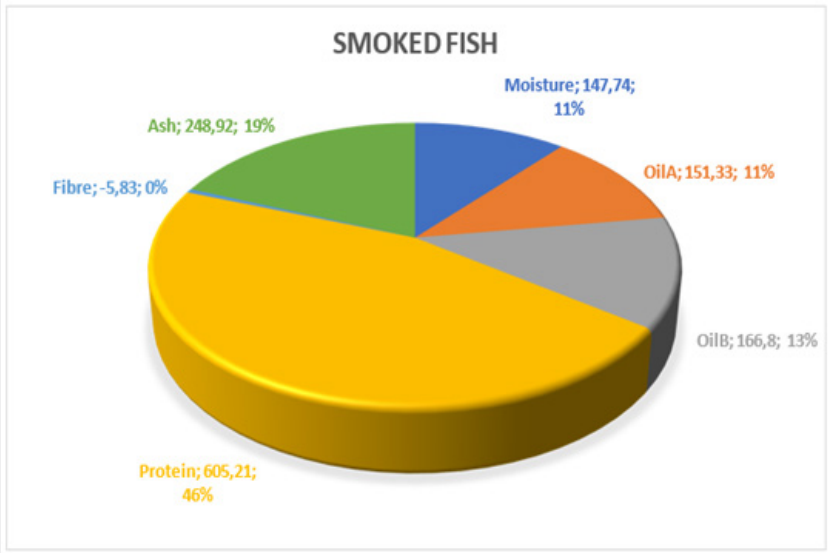

Figure 4: Nutritional content values for smoked fish.

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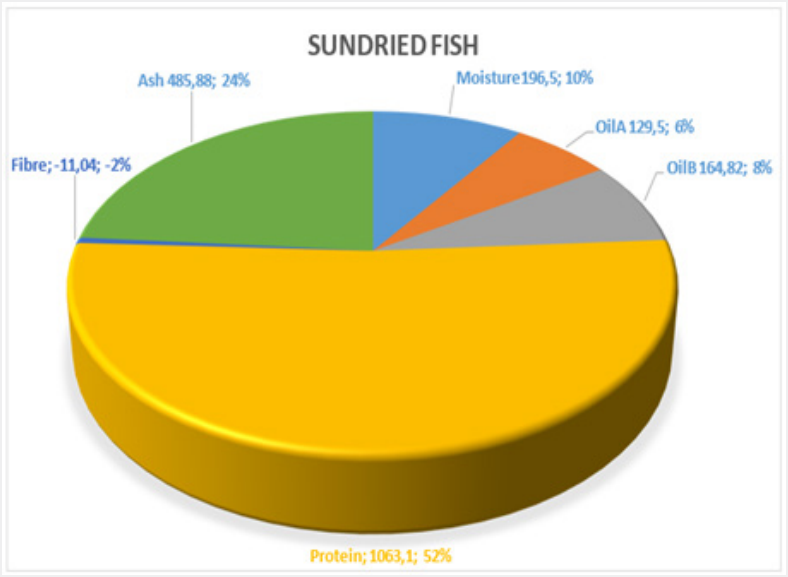

Figure 5: Nutritional content values for sundried fish.

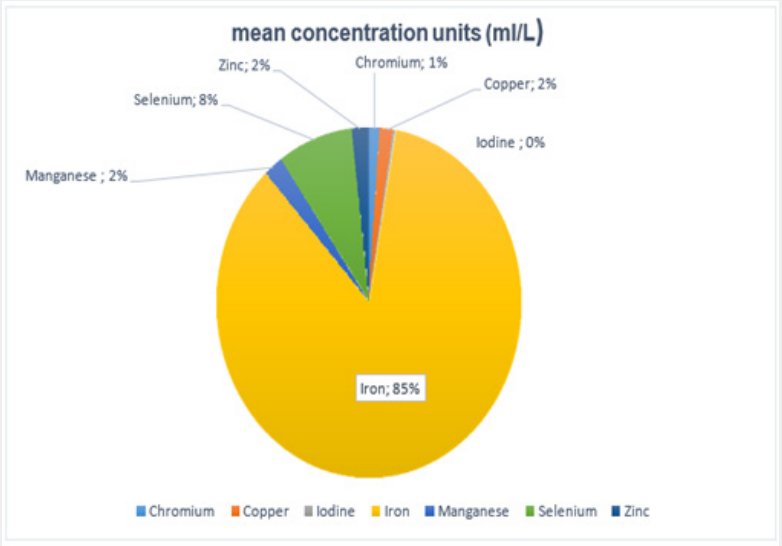

Figure 6: Mean Concentration for salted fish.

The pie chart in figure 6 shows mean concentration for different micro minerals in salted fish.

Figure 7

Figure 7 This graph shows overall mean concentration of different mineral with Iron having the highest concentration and Iodine having the lowest concentration.

Figure 8

The figure above shows the mean concentration in percentage for sundried fish samples with Iron at 92% concentration and 0% for selenium and iodine.

Figure 9

The graph in figure 9 shows Iodine as the lowest concentration and copper with overall 751,23 concentrations in sundried fish.

Figure 10

The above figure shows the mean concentration for minerals in smoked fish samples with chromium at 1% concentration and Manganese at 2% concentration.

Figure 11

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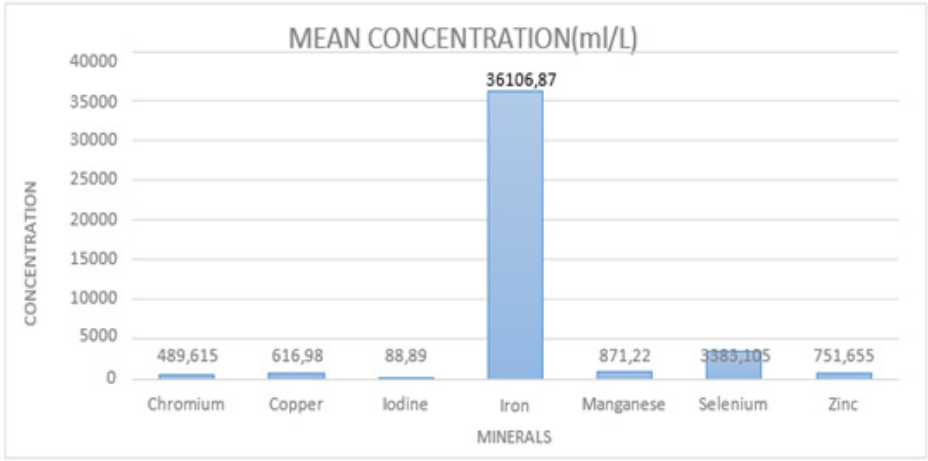

Figure 7: Mean concentration of mineral graph for salted fish samples.

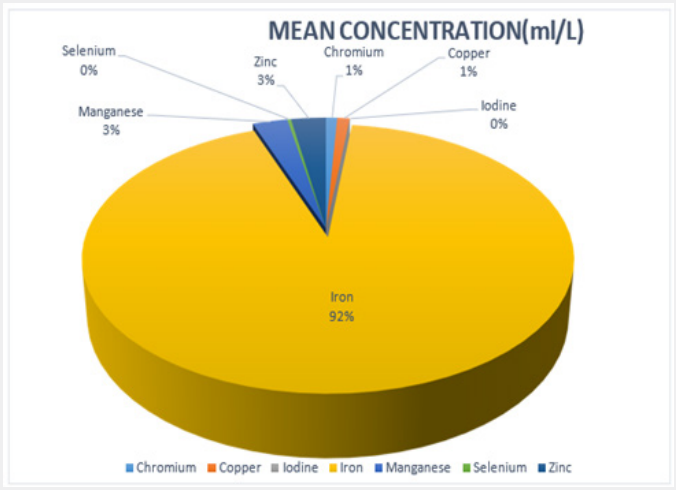

Figure 8: Mean concentration pie chart for sundried fish.

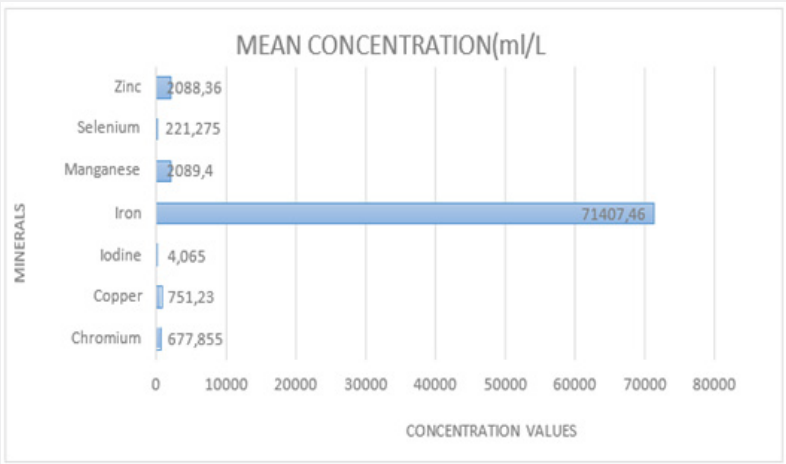

Figure 9: Mean concentration graph for sundried fish sample.

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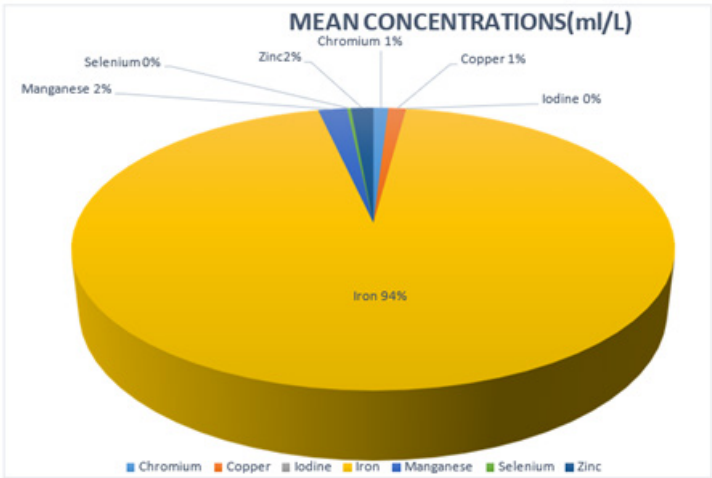

Figure 10: Mean concentration pie chart for sundried fish.

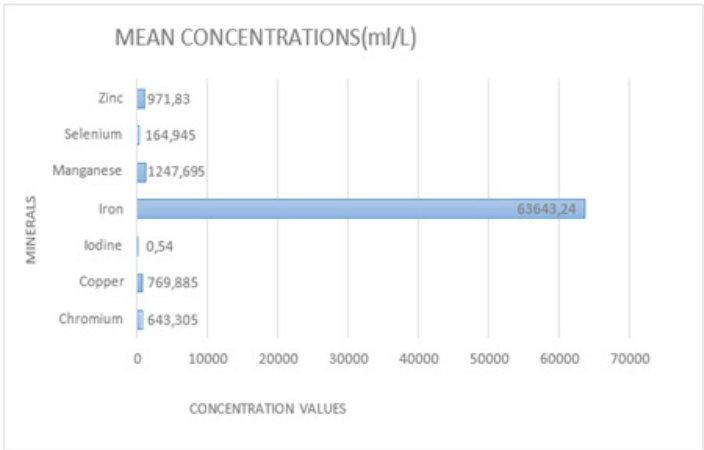

Figure 11: mean concentration in smoked fish samples.

The graph above shows the mean concentration for minerals in smoked fish samples with chromium at 643,305 concentration and Manganese at 124,695 concentrations.

Discussion

The discussion for this research study is based on the results acquired from analysis dried fish using different conservation methods to know its effects on nutritional and mineral content values.

The results for proximate composition for the dried fish are shown in Table 1 where it varies according to different conservation methods used and influenced by different factors such as temperatures and methods of storage. The sundried fish samples had the highest moisture content of 196,5 with smoked having the lowest moisture content of 147,74. Food which contains more than 13% moisture has been reported to have to be vulnerable to putrefaction by microorganisms [20], since salted fish has 19% moisture it becomes more liable to both enzymatic and microbial decomposition during storage.

The moisture content values influenced the values for both Oil A and Oil B, smoked fish had high values for both Oil A and Oil B because of its lower moisture content while salted had the highest percentage for moisture and the lowest Oil content. Sundried had the lowest Oil content compared to smoked as this could be because of oxidation of fat during sun drying [21].

Sundried fish had the highest protein content compared to smoked and salted fish, having 605.21 and 332.97 respectively. This can be due to denaturing of fish protein. The highest fiber content is the of salt with 2% compared to the one of sundried and smoked having the lowest respectively. Salted fish had high fiber with smoked having the least fiber this can because all nutrients become present in fish products during the removal of moisture.

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For all conservation methods, Zinc was found to be the third lowest concentration as compared to the results from a study done by Akinney et al. [21] who found zinc to be the highest concentration in the three species he used this may be due that he only 10% HCI to dissolve his samples and atomic absorption spectrophotometer (model 327) and I used both HCI and nitric acid, analyzed using. Sundried had Iron is the highest concentrate element together with other samples which were smoked and salted, which is the same as the Sardinella spp used in the study of [21].

Micro minerals such as iron and zinc are important but high concentration can be harmful to human health as shown in this study that all samples had high concentration of iron. Manganese, chromium, iodine, and selenium are found to be the lowest concentration in all samples, manganese for this study was found to be higher than the one in the study [22] which was done in Botswana in the region of Chanoga, Okavango Delta, this can be due to different climate conditions, the species variance, and the method of preparation used to analysis the samples [23,24].

Conclusion

This study shows the significant effects of different conservation methods in proximate analysis of dried fish which vary from one conservation process to another. As it is a nutritious aquatic animal it tends to lose its nutritional and mineral content value when exposed to undesirable condition or environment, this can inhabit it from prevents it from achieve its health benefits such as preventing coronary heart disease,

malnutrition, cancer and other diseases when included in dietary plans of humans. This study shows that iron is the most concentrated mineral in all the samples conserved using different methods. Iron was the highest concentration mineral with selenium and Iodine being the lowest concentrate minerals in all the samples this proves that different conservation methods such as sun-drying, salting and smoking affects these minerals the same way. Further research should be done on individual fish species to know the exact fish which is mostly favored by which conservation method. The choice of conservation methods in further studies should be done targeting those methods that conserve microminerals

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Authors Contribution

Mpho Tsheole and Keitiretse Molefe, Mpho Tsheole analyse the topic, digest samples and analyse them. Keitiretse Molefe works on analysing the topic and work on statistical analysis.

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