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CHEMICAL PROPERTIES AND MICROBIOLOGICAL QUALITY OF SALTED DRIED DENIS FISH

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ABSTRACT

Fish is considered an excellent source of highly unsaturated lipids and high biological protein value as well as minerals, and vitamins. Denis (*Sparus aurta*) is a common fish in Egypt and usually sold as a raw product.

Chemical analysis and microbiological quality of fresh and salted dried Denis fish were carried out. Sensory evaluation of fish burger made from fresh and rehydrated fish were also examined. Data revealed that fresh Denis fish is considered as a good source of protein (70.16 % on dry basis) and fat (24.64 % on dry basis). Protein and fat contents decreased with different levels as affected by salting and drying methods, while ash content increased with different levels, compared with fresh and pre-dried sample.

The quality of salted dried Denis fish was determined according to many factors such as non-protein nitrogen (NPN), total volatile nitrogen (TVN), trimethylamine (TMA), ammonia (NH_3) and amino nitrogen (AN) content. Significant differences ($P<0.01$) are observed between the artificial dehydration and sun- dried method as well as significant differences ($P<0.01$) detected between the two levels of NaCl (5% and 10%). Increase of NaCl led to decrease in NPN, TVN, TMA, ammonia (NH_3) and amino nitrogen (AN) content in both artificial drying and sun drying methods. The aforementioned contents in sun dried Denis fish are higher than those found in artificial dehydrated samples. Data indicated also the microbial loads are decrease markedly after salting and drying. The artificially dehydrated samples had lower microbial counts compared to sun- dried method. This is mainly due to the higher and stability temperature used in artificially dehydration than sun-dried method.

Organolyptic evaluation of fish burger processed from fresh Denis fish is more acceptable than that processed from rehydrated fish burger. However, fish burger from rehydrated fish is not bad. The scores of taste, odor, color, texture and overall acceptability is ranged between good to very good.

INTRODUCTION

Fishes are a positive factor in human nutrition because of their highly unsaturated lipids (*Ackman* and *Ratnayake, 1990*). They are also, fish is considered an excellent source of high biological value, proteins, minerals, and vitamins. The nutritional quality of fish is affected by body part of the fish being consumed, method of handling, processing, season of harvest, sex, and species. Fish provides approximately 13.8% -16.5% of the total animal protein intake of the human population. In Egypt, fish provides approximately 7.5% of the total animal protein consumed (*El-Saaid Basuni, 1993*). Average apparent per capita consumption increased from about 8.12 Kg per annum in 1994 to 13.17 Kg in 1999 (*Anon, 2001*). Total fish production In Egypt increased from 546,000 tones in 1998 to 649, 000 tones in 1999 (*Anon, 2001*). Fish is considered spoiled when an undesirable change in the color, flavor, odor or texture has occurred.

One of the first ways to prevent /avoid fish spoilage is by drying and artificial dehydration. The dried seafood product markets is particularly competitive because consumers in specific market tend to prefer one species over another (*Mitchell, 1999*). Dried and dehydration is the oldest methods of food preservation. Quite simply, drying reduces moisture necessary for bacterial growth that eventually causes deterioration. There are various methods of drying and dehydration of fishes which range from simply laying the fish out in the sun on a dry sunny day to solar driers and the most reliable food dehydrators (*Mitchell, 1999*).

Preservation of fish by salting and drying is achieved by lowering the water activity (a_w) of fish flesh. The addition of salt to the fish flesh also alters the state of proteins and enzymes, as well as reduces bacterial growth since most spoilage bacteria, with the exception of halophilic bacteria, can not survive at salt concentrations above 12% wet basis (*Ismail* and *Wooton, 1992*). They added also salting alone, however, does not stabilize fish products sufficiently to allow long-term storage. Thus after salting most products are air-dried to reduce the moisture content to such a level that a_w is sufficiently lowered to prevent or retard spoilage. Most spoilage bacteria will cease to grow in foods whose a_w is below 0.9, mould growth is inhibited below 0.8, halophilic bacteria do not grow below 0.75, and almost all microorganism are inhibited below 0.6.

Dry salted is fish a relatively cheep source of high quality protein especially for those residing in the rural areas (*Abdullah* and *Idrus, 1978*). Salting and sun drying is a popular method of fish preservation throughout Asia and African countries (*Bhandary, 1989*). *Hiroaki* and *Miho* (*1992*) reported that, salted fish has been consumed for generations and constitutes an important part of diets of populations in Japan and developing countries in Southeast Asia.

Denis (*Sparus aurata*) is a common fish in Mediterranean Sea and usually sold as a raw product. The application of drying for the extension of the shelf life is a process of interest especially when using this species of fish instead of imported dried salted fish. The objectives of the present investigation are to obtain information about the chemical composition of Denis fish. In addition studying the effects of salting and different drying procedures on Denis fillet quality as assessed by sensory analysis and determination of biochemical indices and microbiological quality. The effect of storage periods on the chemical and microbiological characteristics of salted dried Denis fish are followed. Besides, manufacture of burger product from the dried fish is also assessed.

MATERIALS AND METHODS

Materials:

1- Fish samples:

Fish samples of Denis *(Sparus aurata)* were obtained from local market with an average weight of about 500 g. Fish samples were immediately cooled in ice Box and transported directly to the Laboratory of Food Science and Technology, National Research Centre, Dokki, Cairo, Egypt. Scales and viscera of fishes were removed and washed. The fish were

subsequently headed and filleted. Some samples were directed to be analyzed chemically and microbiologically, while other samples were prepared for drying processes.

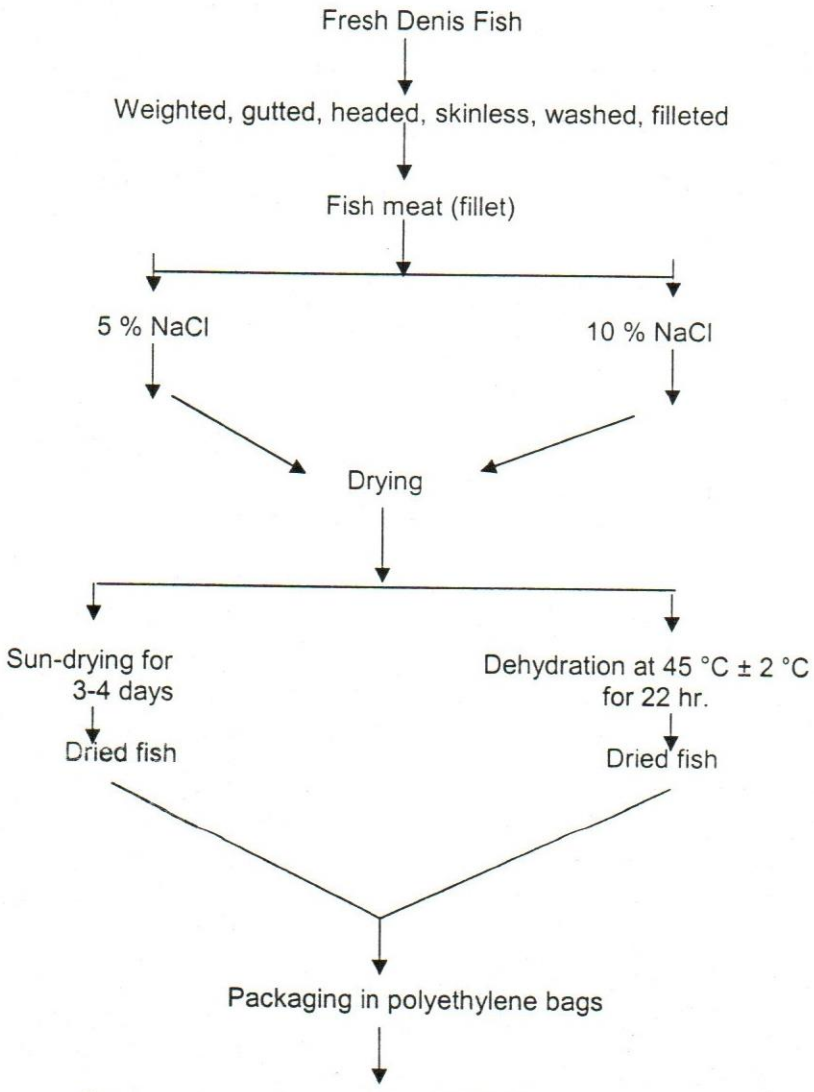

Fig. 1 Dehydration and sun-drying process

2- Salt (sodium chloride) and burger ingredients:

Salt (sodium chloride) was obtained locally from El-Nasr Company and used as it is or being prepared as brine salt solution (5 and 10%). Burger ingredients were purchased from the local market. All chemicals were purchased from Aldrich, Fluka, and Sigma chemicals Co., UK.

Methods:

1- Technological treatments:

Fish samples (first group) were subjected for dry salting in which salt was added to the fish in the ratio of 1:3 (fish: salt) and left for one hour. The second group was soaked in 5 % sodium chloride solution at 4 °C for 1.5 hr. The third group was soaked in 10 % sodium chloride solution at 4 °C for 1.5 hr. Control samples include unsalted fish (group 4). After brining process each group (two, and three) were divided into two portions. The first one was dried under artificial conditions and the other one was dried by sun-drying process (Fig 1).

2- Artificial dehydration and sun-drying of fish:

Salted fish samples were placed over dehydration trays, which loaded, in a drier cabient provided with a fan and thermostatically controlled electrical heater. During the whole period of partial drying which recorded 22 hours, the dry bulb temperature was adjusted to 42-45 °C. Sun-drying of prepared fish samples was carried out for 3-4 days. In such a case, samples were hunged and surrounded with tolly cloths to protect the fish against insects. After drying, dried fish were packed under vacuum in sealed polyethylene bags and stored at room temperature (25-30 °C).

3- Preparation of fish burger from dried fish:

Dried Denis fish were cutted into small pieces and ground, then partially rehydrated in water (10:100 w/v). Burger from rehydrated fish was prepared according to *Arocha* and *Toleda* (*1982*) using the following formula (1 kg mixture): 400 g rehydrated fish, 200 g chopped onion, 100 g chopped red capsicum, 100 g chopped celery, 50 g dried bread crumbs, 15 g chopped fresh dill, 85 g lemon juices, 30 g vegetable oil, 5 g salt, and 15 g mayonnaise. The ingredients were combined in a bowl and blended for approximately 2 min. to ensure distribution and the burgers were formed at ~3 °C. Fish burgers of approximate diameter 90 mm and thickness 10 mm were placed on trays, covered with waxed discs and allowed to settle for 2 h. Trays of burgers were frozen overnight at -18°C. After that burgers were packed in pairs of polyethylene bags and kept at -18°C until required or use

Analytical methods:

1- Chemical analysis

Fish samples were minced and mixed well, then moisture content, total protein (N x 6.25), total lipids, ash, total volatile nitrogen (TVN), trimethyl amine (TMA), ammonia (NH_3) and amino nitrogen (AN) were determined according to the methods of *AOAC* (*1995*). Non protein nitrogen (NPN) was determined according to the method described by El-*Gharabawi* and *Dugen* (*1965*).

2- Microbiological analysis

Total bacterial count were enumerated on plate count agar medium as described by *(APHA, 1992),* for foodstuff examination. *Halophilic bacteria* were carried out on tryptone-soy agar medium as well as total mold and yeast counts were counted on oxytetracycline glucose yeast extract agar medium according to *Oxoid Manual* (*1980*). *Coliforms* were enumerated on Maconky agar medium as recommended by *Mossel* (1975). *Salmonella* were examined

using the most probable number technique according to *ISO (1975)*. *Vibrio costicola* was examined on thiosulphate citrate bile salt sucrose (TCBs) agar medium by the described by *Taylor et al., (1982)*. *Micrococcus, Planococcus* and *Bacillus* were examined according the methods of (*APHA*, 1992).

3- Organolyptic evaluation

Texture, odor, taste, color, and overall acceptability were carried out according to *Watts et al., (1989)* by ten members of panelist. The panelists were asked to evaluate the products according to the overall acceptability on the nine-point hedonic scale: (9-8) very good, (7-6) good, (5-4) fair, (3-2) poor, and (1-0) very poor.

Statistical analysis

Data were subjected to computerized towards analysis of variance (ANOVA) and Duncan's multiple range test procedures using (*SAS,1998*)

RESULTS AND DISCUSSION

Effect of salting and drying on the chemical composition of Denis fish:

Data presented in Table (1) showed that fresh Denis fish contained 72.32%, 19.42%, 6.82%, and 1.46% on wet basis of moisture, total protein, crude fat, and total ash, respectively. From these data, Denis fish is considered as a good source of protein (70.16% dry basis) and fat (24.64% dry basis). Similar results obtained by *Alasalvar et al. (2001)* who found that the same type of fish contained moisture, total protein, crude fat and total ash at levels of 74.74%, 18.0%, 6.53%, and 1.53% on wet basis, respectively.

The effect of pre-drying (salting by dry method for one hour, and soaking in 5% or 10% sodium chloride solution) and drying methods (artificial dehydrated and sun-dried methods) on the chemical composition of Denis fish are studied (Table 1). Due to salting by the dry method, the moisture content decreased from 72.32% to 61.1%. This means that fish muscles loss 11.22% of their moisture content. When the fish samples soaked in 5% or 10% NaCl solution, the moisture content slightly increased to 65.3% and 66.5%, respectively compared with dry salting but still less than the fresh fish. After drying, the final product recorded (31.8% and 30.96% moisture) with dehydration and (33.11% and 32.24% moisture) when using the sun-drying method. These results indicate that sun-dried samples had higher moisture content than the dehydration one and this may be due to the higher and controlling of temperature degree during dehydration than sun-dried method. Similar results are obtained by *Astawan et al. (1994)* who found that the amount of moisture of salted sun-dried Mackerel was 35.52%. In addition (*Galhom, 2002*) reported that the moisture content was found to be ranged from 34.71% to 35.21% for salted dried Bolti and from 36.4% to 37.18% for salted dried Keshr-Bayad. Moisture content of dried fish was considered one of the most important factors, which control the quality of dried fish. The main purpose of drying process is to reduce the moisture content to a level that can prevent growth of microorganisms and consequently fish spoilage. *Sen et al. (1961)* found that salt-cured Mackerel dried to moisture content below 35% is not susceptible to bacterial spoilage and mold growth.

Protein, among several biochemical components, are considered to be the most important for determining the nutritional and sensory quality of the dried fish because of it's denaturation by many factors such as salt concentration, salting time, drying temperature, and drying method (*Shoji et al., 1990*). Based on a dry weight basis, crude protein slightly decreased during salting process (Table 1). This loss could be attributed to the leaching out of some soluble protein fractions from fish muscles during salting process (*De Silva* and *Rangoda, 1979*). Protein content of salted dried Denis fish are (65.84% and 65.93% dry basis) and (65.78% and 65.88% dry basis) for the dehydrated and sun dried samples, respectively. The decrease of protein content of dried fish might be due to the action of internal enzymes and microorganisms which converted the protein macromolecule to smaller fraction of volatile nitrogenous substances (*El-Saaid Basuni, 1993*). The values of protein in salted dried fish under investigation were higher than those reported by *Balogun* (*1988*) who found that total protein content of sun-dried Clupeids were 62.1 % ± 3.2% (dry weight basis). However, these values were lower than those detected by *Galhom,* (*2002*) who showed that protein content ranged between 74.55% to 74.64% and 74.64% to 74.67% in sun-dried and artificial dried Bolti fish (dry weight basis), respectively. These differences of protein content may be due to fish type, salting and drying methods.

Table (1): Effect of pre-and drying treatments on the chemical composition of Denis fish*

Composition %	Fresh Fish	Pre-drying			Drying method			
					Artificial drying		Sun-drying	
		1	2	3	5% NaCl	10% NaCl	5% NaCl	!0% NaCl
Moisture	72.32	61.10	65.30	66.50	31.80	30.96	33.11	32.24
Total protein	19.42 (70.16)**	26.92 (67.92)	23.26 (67.03)	22.11 (66.00)	44.90 (65.84)	45.52 (65.93)	44.00 (65.78)	44.00 (65.88)
Crude fat	6.82 (24.64)	8.60 (22.11)	7.50 (21.61)	7.10 (21.19)	14.62 (21.44)	14.45 (20.93)	13.30 (19.88)	13.50 (19.92)
Total ash	1.46 (5.24)	3.40 (8.74)	3.25 (9.37)	3.10 (9.25)	9.86 (14.46)	10.12 (14.66)	9.80 (14.65)	10.05 (14.83)

*Data are expressed as mean (n=5) ** % on dry weight basis

1. Salting by the dry method for one hour
2. Soaking in 5% NaCl solution after salted dry method
3. Soaking in 10% NaCl solution after salted dry method

Data in Table 1 indicated that crude fat content is slightly decreased during salting and drying method. This could be attributed to the leaching out of fat from fish muscles during salting process as well as the effect of heat that used during drying which might have caused melting and dripping of some fish fats (*Hammad, 1985*). On the other hand, *Smith* and *Hole,* (*1991*) reported that the slight decrease of crude fat content of dried fish samples might be attributed to the lipid oxidation during process and storage. Crude

fat content in the investigated dried salted fish is (21.44% and 20.93% dry basis) and (19.88% and 19.92% dry basis) with artificial dried and sun-dried method, respectively. Similar trend observed by *Galhom, (2002)* who showed that fat content of salted fish samples were 14.76% and19.35 % on dry basis for Bolti fish and Keshr-Bayad fish, respectively. He added also, crude fat contents in the fish samples prepared by sun-dried and artificial drying was ranged between (9.14% -9.71%) and (10.17% -11.06% dry weight basis) for salted dried Bolti and Keshr-Bayad fish, respectively.

Total ash in the same fish samples increased during salting process and drying method (Table 1). The high ash content could be due to the inorganic impurities in the used salt for salting process as previously reported by *Abo-Raiia (1975)*. There were no distinguishable differences observed for total ash content between the samples dried either by artificial dehydration or sun-drying method. The total ash in dried salted Denis fish was (14.46% and 14.66% dry basis) and (14.65% and 14.83% dry basis) with artificial dehydration drying and sun-dried method, respectively. The obtained results coinicided with those reported by *Galhom (2002)* who showed that salted Bolti and Keshr-Bayad fish contained ash ranged between (13.46% to 19.32 % dry weight basis) and (11.82% to 14.65% dry weight basis), respectively. The author added that total ash in salted dried fish was ranged between (15.13% to 15.65%) in salted dried Bolti and (16.25% to 16.78%) in dried Keshr-Bayad.

Chemical, microbiological and sensory evaluation of salted dried fish:

Protein degradation, microbial spoilage and associated changes are a major cause of quality deterioration of fish during manufacturing and storage. Problems associated with protein degradation are of importance as they relate to flavor deterioration and loss of nutritional values, thereby affecting the acceptability of fish storage (Shoji et al., 1990). Chemical, microbiological and sensory evaluation of salted dried Denis fish at different levels of salt (5% and 10%) by artificial dehydrated and sun-dried methods are given in Tables (2-6).

Chemical evaluation:

1- **Non-protein nitrogen (NPN):-**

NPN represents the compounds produced as a result of protein degradation. Data presented in Table 2 indicate the changes of NPN content of salted dried Denis fish. It is evident from the table that there are significant differences ($P<0.01$) between the artificial dehydration and sun-dried method as well as significant differences between the two levels of sodium chloride (5% and 10%). It could be observed that, the increase of NaCl led to decreasing in NPN content. Salt soluble NPN fraction is considered to be a relatively good index of proteolysis which lead to a protein breakdown by the proteolytic enzymes (*Khan, 1964*). *Hafiz (1973)* studied the changes of nitrogenous fractions in salt solution of Aswan Bolti fish tissues. The author found that there were two adversative processes that may take place, the first process was denaturation and aggregation of protein leading to the increase of meat hardness and the second process was limited proteolysis leading to the increase of meat tenderness. NPN content in sun-dried salted fish under

study (0.266% with 5% NaCl and 0.242% with 10% NaCl) was higher than those in artificial dehydrated samples (0.172% with 5% NaCl and 0.159% with 10% NaCl). These differences may be due to the temperature degree and the period of drying. Similar results obtained by *Galhom (2002)* who found that the NPN content was 0.19% - 0.23% on raw dried weight basis in artificial dried and 0.18% - 0.19% in sun-dried fish.

2- Total volatile nitrogen (TVN):-

Total volatile nitrogen could be used as an indicator of fish spoilage due to protein degradation (*El-Saaid Basuni, 1993*). The maximum acceptable level for fresh fish muscle is 30 mg/100g sample (*EOS, 1990*). From data in Table 2 it is obvious that there were significant differences ($P<0.01$) between the artificial dehydration and sun- dried methods. Data indicated also sun-dried salted fish showed a higher significant level ($P<0.01$) of TVN content than that of the dehydrated samples. These results may be due to protein breakdown by proteases enzymes. TVN content in this study is lower than that reported by *Galhom (2002)* who found that TVN was ranged from 21.86-22.66 mg/100g 20.43-21.28 mg/100g for Bolti and Keshr-Bayad fish, respectively.

Table (2): Changes of non-protein nitrogen (NPN %) and total volatile nitrogen (TVN mg/100g) content of salted dried Denis fish.

Treatments NaCl %	Raw		Artificial drying		Sun-drying	
	NPN %	TVN mg/100g	NPN %	TVN mg/100g	NPN %	TVN mg/100g
0	0.144^{g} ± 0.00	4.51^{g} ±0.26	0.187^{d} ± 0.01	7.14^{b} ± 0.05	0.292^{a} ± 0.01	7.62^{a} ± 0.04
5	0.155^{g} ± 0.00	5.47^{e} ± 0.02	0.172^{e} ± 0.002	6.74^{c} ± 0.03	0.266^{b} ± 0.001	7.50^{a} ± 0.01
10	0.147^{g} ± 0.001	5.14^{f} ± 0.09	0.159^{f} ± 0.001	6.08^{d} ± 0.03	0.242^{c} ± 0.001	6.65^{c} ± 0.05

a,b,c,....Means values in each columns having different superscript are significantly different at ($P< 0.01$).

3-Trimethylamine (TMA) and Ammonia (NH_3):-

Trimethylamine content is used as an index of deterioration level and spoilage of salted fish and could be considered as one of freshness index for the quality of salt-water fish (*Krzymien and Elias, 1990*). TMA is produced from trimethylamine oxide (TMAO) possibility by the action of intrinsic enzymes but certainly through bacterial action (*Rodriguez et al., 1999*). Data in Table 3 shows TMA contents (mg/100g) of the salted dried Denis fish prepared by the two methods of drying. TMA content is higher in sun-dried samples than that of the artificial dehydrated one and the significant differences ($P<0.01$) that observed between the two methods confirmed such conclusion. In other words, in case of sun drying technique the curing proceeds so slowly in most cases given a chance for reduction changes to occur and reduced the TMA oxide content to TMA. These results means that the long drying time of fish made lead to reasonable conditions for producing of reductant compounds which convert TMA oxide to TMA. The content of

TMA in fresh and salted fish in the present study is lower than that reported by *Galhom (2002)* who found that TMA was (3.92-4.06 mg/100g) and (3.2-3.39 mg/100g) with salted dried Bolti and Keshr-Bayad fish, respectively. The initial TMA content of Club Mackerel fillets is low (1.22 mg /100g of sample) indicative of the freshness of the samples (*Goulas* and *Kontominas, 2005*). According to *Connell (1990)* a value of 1.5 mg TMA of product has been recommended as an upper limit for very good quality cod. *Maga (1978)* reported that fresh fish had 3.37 mg/100g, fairly fish had 12.65-16.2 mg/100g, while spoiled fish contained as high as 59.01 mg/100g. Of-course it has been shown that levels of TMA depend on species, age, time of year, muscle type, and diet of fish (*Rodriguez et al., 1999*). The results obtained proved that the fresh or salted dried fish under investigation within the normal range of acceptable level of nitrogenous basis compounds. With respect to ammonia content of the tested salted dried fish, the available data (Table 3) proved the presence of reversible correlation between ammonia and salt concentration. On the other hand, ammonia content showed the highest level in sun-dried samples beside the presence of significant differences ($P<0.01$) which indicating the breakdown of proteins by proteolysis. The bacterial action on protein may lead to the formation of ammonia and other compounds (*Demyer and Vandekerchkova 1979*).

Table (3): Changes of trimethylamine (TMA mg/100g) and ammonia (NH_3) (mg/100g sample) content of salted dried Denis fish.

Treatments NaCl %	Raw		Artificial drying		Sun-drying	
	TMA mg/100g	NH_3 mg/100g	TMA mg/100g	NH_3 Mg/100g	TMA mg/100g	NH_3 mg/100g
0	2.07^{n} ±0.03	2.09^{n} ±0.04	4.14^{b} ± 0.05	2.69^{ef} ± 0.04	4.53^{a} ± 0.04	2.85^{bc} ± 0.03
5	2.53^{i} ± 0.04	2.73^{de} ± 0.02	3.74^{d} ± 0.03	2.80^{cd} ± 0.01	4.09^{b} ± 0.04	3.19^{a} ± 0.02
10	2.35^{j} ± 0.01	2.61^{f} ± 0.02	3.19^{e} ± 0.04	2.49^{g} ± 0.02	3.83^{c} ± 0.01	2.92^{b} ± 0.04

a,b,c,....Means values in each columns having different superscript are significantly different at ($P< 0.01$).

4-Amino nitrogen content (AN):-

Data in Table 4 shows the concentration of amino nitrogen (AN) content (mg/100g sample) as affected by salting (5% and 10%). As a result of drying, amino nitrogen content decreased compared with its level in the investigated raw samples. However, amino nitrogen content was higher in sun-dried samples than that artificial dehydrated samples, which significant differences ($P<0.01$) was observed between the two methods. These results indicate the breakdown of proteins by proteolysis. However, *Haaland* and *Njaa (1988)* reported that the formation of NH_3-N might be accomanied by a parallel decrease in amid-N.

Table (4): Changes of amino nitrogen (AN) (as mg/100g sample) content of salted dried Denis fish.

Treatments NaCl %	Raw	Artificial drying	Sun-drying
0	138.66^{c} ±0.03	111.14^{e} ± 0.03	121.07^{d} ± 0.08
5	140.88^{a} ± 0.37	105.38^{f} ± 0.26	111.06^{e} ± 0.26
10	139.46^{b} ± 0.27	100.41^{h} ± 0.41	104.46^{g} ± 0.27

a,b,c,.... Means values in each columns having different superscript are significantly different at (P< 0.01).

Microbiological evaluation of dried salt Denis fish:

The microbiological aspects of fresh and salted dried Denis fish are studied and the obtained data are shown in Table 5. It could be observed that total aerobic bacteria is determined to be 3.8 x 10^4 , molds 1.3 x 10, yeast's 1.5 x 10 c.f.u /g , *Pediococcus halophilus* 20%, and *Micrococcus* 70% in fresh Denis fish. On the other hand, *Coliform, Vibrio costicola; Planococcus, Bacillus and Salmonella were out of* detection in fresh fish. These counts are lower than range counts of fresh Bolti and Keshr-Bayad as reported by *Galhom (2002)*. The total counts of bacteria in the samples under investigation were lower than the average bacterial count of fresh Pikeperch fish (4.3 x 10^5 cell /g) and Bolti fish (7.1 x 10^5) that given by *Hammad (1985)*. The obtained results indicated that the microbial loads are decreased markedly after salting and drying. This reduction could be due to the increase of salt concentration in fish tissue by removal of water during dehydration as well as the reduction of water activity.

Table (5): Distribution of microorganisms in fresh fish, pre-and drying Denis fish*

Parameters	Fresh Fish	Pre-drying			Drying method			
					Artificial drying		Sun-drying	
		1	2	3	5% NaCl	!0% NaCl	5% NaCl	!0% NaCl
Total aerobic Bacteria	3.8x10^4	1.1x10^4	6.6x10^3	4.1x10^3	2.2x10^3	0.9x10^3	2.8x10^4	1.9x10^4
Coliform	-	-	-	-	-	-	-	-
Molds	1.3x10	1.2x10	1.1x10	1.1x10	0.8x10	0.4x10	0.9x10	0.5x10
Yeast's	1.5x10	1.3x10	1.2x10	1.2x10	1.1x10	0.6x10	1.2x10	0.9x10
Fediococcus Halophilus %	20	15	12	10	12	8	16	10
Micrococcus %	70	60	55	50	60	52	66	60
Vibrio Costicola %	–	–	–	–	–	–	–	–
Planococcus %	–	–	–	–	–	–	–	–
Bacillus	–	–	–	–	–	–	–	–
Salmonella	–	–	–	–	–	–	–	–

*Means values of three replicates
1.Salting by the dry method for one hour
2.Soaking in 5% NaCl solution after salted dry method
3.Soaking in 10% NaCl solution after salted dry method

The obtained data indicated that artificial dehydrated samples had lower microbial counts compared to sun-dried method. This is mainly due to

the controlling of the applied temperature used in artificial dehydration. In addition, sun-dried fish tend to be contaminate by microorganisms and many other impurities. These results coinicided with that obtained by *Galhom (2002)* who reported that T.C in dehydrated and sun-dried samples were (33-34 x 10^3) and (34-35 x 10^3), respectively. Similar trend was found by *Moghazy* and *El-Seesy (2000)* who showed that total microbial count of salted dried fish was ranged between (34-38 x 10^3 c.f.u/g) and (45-39 x 10^3 c.f.u g) for Keshr-Bayad fish and Bolti fish samples, respectively. On the other hand, the distribution of microorganisms in 10 samples of salted dried fish were studied by *Ito and Abu* (1985). They found that the total aerobic bacteria were ranged from 2 x 10^4 to 3 x 10^6 c.f.u/g. Molds counts from 1 x 10^2 to 7 x 10^3 c.f.u/g and lower amount of yeast's ranged from 4.4 x 10^1 to 2.3 x 10^3 c.f.u/g. *Coliform* were not isolated on Maconkey agar plates from any of the samples. The author reported that the predominant bacteria occurring in spoiled dried fish were identified as *Pediococcus halophilus, Vibrio costicola* and *Planococcus sp.*

Chemical and microbiological characteristics of artificial dried Denis fish during storage:

Data presented in Table 6 shows the chemical and microbiological characteristics of salted dried Denis fish during storage for three months. Results indicated that NPN, TVN, TMA, NH_3 and AN slightly increased to 0.22, 11.12, 4.6, 3.8 and 121.0 mg/100g, respectively in salted (5% NaCl) dried Denis fish at the end of storage period (3 months). The corresponding values with 10% NaCl were 0.18, 8.95, 4.2, 3.15 and 115.0 mg/100g, respectively. Regarding to microbiological analysis, it could be observed that total aerobic bacteria (T.C) is determined to be 3.9 x 10^3, molds 1.1 x 10 and yeast's 1.4 x 10 c.f.u/g in salted (5% NaCl) dried fish as well as to be 1.5 x 10^3, 0.7 x 10 and 0.9 x 10 c.f.u/g for T.C, molds and yeast's, respectively with 10% NaCl. These results proved that the quality of salted dried Denis fish could be used up to three months without any deterioration during storage.

Table (6): Chemical and microbiological characteristics of artificial dried Denis fish during storage.

Items	Storage periods (months)							
	0 time		1 month		2 month		3 month	
	NaCl %		NaCl %		NaCl %		NaCl %	
	5	10	5	10	5	10	5	10
Chemical evaluation								
1-NPN	0.172	0.159	0.180	0.16	0.22	0.18	0.22	0.18
2-TVN	6.74	6.08	7.55	6.95	8.35	7.80	11.12	8.95
3-TMA	3.74	3.19	3.85	3.55	4.10	3.70	4.60	4.20
4- NH_3	2.80	2.49	3.11	2.60	3.60	2.80	3.80	3.15
5- AN	105.38	100.4	110.0	105.0	115.6	109.4	121.0	115.0
Microbiological Evaluation								
1-T.C	$2.2x10^3$	$0.9x10^3$	$2.6x10^3$	$1.1x10^3$	$3.1x10^3$	$1.3x10^3$	$3.9x10^3$	$1.5x10^3$
2-Mold	0.8x10	0.4x10	0.9x10	0.5x10	1.1x10	0.5x10	1.1x10	0.7x10
3-Yeast's	1.1x10	0.6x10	1.2x10	0.8x10	1.4x10	0.9x10	1.4x10	0.9x10

Organolyptic Evaluation of fish burger:

The organolyptic qualities of fish and its products were essential factor in the palatability and consequently the acceptance of such products. Taste, odor, color, texture and overall acceptability were used as organolyptic evaluation factors for rehydrated fish burger and to be comparable with those of fresh fish (Table 7). Results indicate that, fish burger samples prepared from fresh fish are more acceptable than those prepared from the rehydrated fish. Therefore, statistical analysis proved that a significant difference ($P<0.01$) observed between the fish burger from rehydrated or fresh fish. Regarding to the scores of taste, odor, texture, color and overall acceptability in fish burger from fresh fish. It could be noticed that the scores are ranged between 8.0 and 9.5 (very good). However, fish burger from rehydrated fish was not bad. The scores of items were ranged between 7.3 and 8.8 (good to very good).

Table (7): Organolyptic evaluation of fish burger* from fresh and rehydrated fish

Items	From fresh fish	From rehydrated fish
Taste	8.3^{a}	7.3^{b}
Odor	9.5^{a}	7.5^{b}
Texture	8.3^{a}	7.3^{b}
Color	9.0^{a}	8.8^{ab}
Overall acceptability	8.0^{a}	7.5^{b}

Conclusion

From the aforementioned results, it could be concluded that, Denis fish is considered an excellent source of proteins and fat. The application of drying with salt for extension of shelf-life is a process of interest. Protein degradation, microbial spoilage and associated change are a major cause of quality deterioration of fish during manufacturing and storage. The quality of fish is determined according to many factors such as NPN, TVN, TMA, ammonia NH_3 and amino nitrogen (AN). Increase of NaCl led to decrease of these factors as dehydrated and sun-dried method. These factors in sun-dried salted fish were higher than in dehydrated fish. These differences may be due to the temperature degree and the period of drying. The microbial loads were decreased markedly after salting and drying. It could be recommended that artificial dehydration method with 10% NaCl for Denis fish is very important for the extension of the shelf-life of the product.

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الخواص الكيميائية و الجودة الميكروبيولوجية لسمك الدنيس المجفف المملح

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تعتبر الأسماك من المصادر الغذائية الهامة للإنسان وذلك لإرتفاع محتواها من الأحماض الدهنية غير المشبعة بجانب محتواها المرتفع من البروتينات والعناصر المعدنية والفيتامينات. ويعتبر سمك الدنيس من الأسماك الشائعة والتى يتم صيدها من البحر المتوسط بكميات كبيرة وتستهلك طازجة. و نظرا لإرتفاع المحتوى المائي للأسماك بالإضافة إلى الأحماض الأمينية الحرة مع وجود الأنواع المختلقة من الكائنات الحية الدقيقة على جسم الأسماك وتوفر الظروف البيئية المناسبة فإن ذلك قد يؤدى إلى سرعة فساد هذه الأسماك . لذا فإن هذا البحث يقوم أولا بإلقاء الضوء على التركيب الكيميائي لأسماك الدنيس نظرا لإفتقار الكثير من المعلومات عنه وكذا دراسة إمكانية إطالة مدة حفظه بإستخدام طرق التجفيف المختلفة سواء فى الأفران أو التجفيف الشمسي مع التمليح بنسب مختلفة وذلك للحصول على سمك دنيس مجفف مملح يصلح للإستخدام لفترات طويلة مع معالجة بعض المشاكل التسويقية وتكاليف النقل وقد تم الحكم على جودته بإجراء تقييم كيميائي وميكروبيولوجى للسمك الناتج بالإضافة إلى ذلك تم تصنيع أحد المنتجات المحببة لدى المستهلكين وهو البرجر والذي يتم صناعته أساسا من اللحوم وذلك لتشجيع إستهلاك بعض منتجات الأسماك السريعة وإجراء تقييم حسى للمنتج للوقوف على مدى قبوله أو رفضه من قبل المستهلك وقد إتضح من النتائج المتحصل عليها مايلى:-

١- أن أسماك الدنيس من الأسماك المرتفعة فى محتواها من البروتين (٧٠,١٦ % على أساس الوزن الجاف) والدهون (٢٤,٦٤ % على أساس الوزن الجاف).

٢- بدراسة تأثير نسب التمليح (٥ ، ١٠ % كلوريد صوديوم) وطريقة التجفيف سواء بالأفران أو التجفيف الشمسى على التركيب الكيميائى للأسماك لوحظ أن نسبة البروتين والدهن قد انخفضت بنسب مختلفة تبعا لنسبة الملح وطريقة التجفيف.أما نسبة الرماد فقد ازدادت بنسب مختلفة مقارنة بالعينات الطازجة والمملحة قبل التجفيف.

٣- لوحظ أن هناك فروق معنوية بين طرق التجفيف (سواء بالأفران أو التجفيف الشمسى) ونسب التمليح (٥ % أو ١٠ %) على دلائل الجودة الكيميائية (النيتروجين الغير بروتيني- النيتروجين الكلى المتطاير- الثلاثي ميثيل أمين- الأمونيا- النيتروجين الأمينى) للأسماك المجففة المملحة .

٤- إنخفاض الحمل الميكروبي فى الأسماك المجففة نتيجة لتأثير عمليات التمليح والتجفيف وقد كانت عينات الأسماك المجففة بطريقة الأفران أقل فى محتواها الميكروبى عن مثيلتها المجففة بالتجفيف الشمسي. ويرجع ذلك إلى درجة حرارة التجفيف بالأفران وثباتها خلال فترة التجفيف.

٥- التقييم الحسي للبرجر المصنع من أسماك الدنيس الطازج أو المجفف أظهر أن هناك فروق معنوية من حيث الطعم و الرائحة واللون والتركيب وقد أثبت التحليل الإحصائي أن البرجر المصنع من الأسماك الطازجة أكثر قبولا من المصنع من أسماك الدنيس المجففة مع العلم بأن درجات تحكيم المنتج المصنع من الأسماك المجففة لم تكن سيئة حيث تراوحت قيم التحكيم من جيد إلى جيد جدا.