



ARTICLE

Using Green Cold Pressing to Produce High Quality Fish Oil From Industrial Salmon Waste

Tarek Fouda *

Department of Agricultural Engineering, Faculty of Agriculture, Tanta University, Egypt

ARTICLE INFO

Article history

Received: 18 June 2020

Accepted: 27 June 2019

Published Online: 30 June 2020

Keywords:

Salmon

Waste extract

Efficiency

Yield

Smoking

Fish oil

Cold pressing

Wet rendering

ABSTRACT

The main objective of this research was to determine the amount of oil fish were extracted from fish waste resulted from butchering, cutting and splitting processes before salmon smoking by using cold pressing methods. The amount and the characteristics of extracted oil were tested at Regional Centre for food and feed the USDA Agricultural Research Center laboratory. The samples were used from fresh Salmon waste about 1000g from each of the (head, skin, viscera, backbone, frames and cuts off). This waste recorded more than 22% of the total mass from salmon fish with used modern extract machine. In this experiment the results revealed the fresh salmon waste have more than 16% of oil fish per one kg of salmon waste. The oil weight from Salmon waste for (head, skin, viscera, backbone, frames and cuts off) was increased with pressing time increase as well as oil productivity increased. The optimum conditions at pressing time was 200 min, for all salmon waste components. Oil productivity fluctuated according to waste sources was 190, 210, 86, 188, 178 and 90 g.oil/1000 g. by head, skin, off cuts, tering, viscera, and backbone frames, Salmon by-products, oil productivity was ranged between 8.60 to 21.00% at constant pressure. High contents of functional EPA (20:5 ω 3) and DHA (22:6 ω 3) for oil fish.

1. Introduction

Fish is one of the most perishable of all staple commodities. Spoilage occurs as the result of the action of enzymes (autolysis) and bacteria present in the fish and also chemical oxidation of the fat which causes rancidity. At the high temperatures prevalent in tropical countries, bacterial and enzymic actions are enhanced. Fish invariably become putrid within a few hours of capture unless they are preserved or processed in some way to reduce this microbial and autolytic activity and, hence,

retard spoilage. If the moisture content of fresh fish is reduced during drying to around 25%, bacteria cannot survive and autolytic activity will be greatly reduced, but to prevent mould growth, the moisture content must be reduced to 15%. Also the presence of salt retards bacterial action and, in addition, it aids the removal of water by osmosis [5].

Cold press is preferred due to its wide usage areas, simple use, lack of manpower, low cost, environmentally friendly, lack of harmful organic solvents and high-quality production possibilities. In addition, generally the product

*Corresponding Author:

Tarek Fouda,

Department of Agricultural Engineering, Faculty of Agriculture, Tanta University, Egypt;

Email: tfouda628@gmail.com; tfouda@yahoo.com

is not applied to heat treatment (cold press), therefore, as mentioned in the study, high-quality oils are obtained. In the cold pressed process oil extraction relies solely on the pressure. No, or very little, heat is added to the paste to assist in the extraction. Cold presses are usually mechanically operated and often consist of a screw device that is tightened against the paste to extract the oils. Cold pressing usually produces a lower-yield, but higher quality of oil [11].

Primary and secondary processes using to prepare salmon fish for handling and smoking the waste rustling from gutting & deheading, grading - whole fish, desliming and weighing as primary processes and filleting, trimming, pin bone removal, skinning, fillet washing and grading fillets as secondary processes varied to have head, skin, viscera, backbone, frames and cuts off. Management and handling of fish waste is an environmental, social priority for many countries and is more problematic because of rising production volumes. The fish processing industry causes a large quantity of tissue waste and by-products which tend to be either discarded or retailed at low value for fertilizer or animal feed [6].

The fish by product is nearly (skin 6%, viscera 7%, off-cuts 10%, head 18% - backbone frames 10%) [10].

The fish processing industries produce large quantities of fish waste which often represent about 20-50% of the total fish weight [3].

Fish by-products included viscera, head and skin, which had a lot of unexploited potential for value adding and some of them were being utilized at present. Fish oil could be produced by several methods which included hydraulic pressing, vacuum distillation, urea crystallization, supercritical fluid extraction, which all require high temperature or high pressure in processing or reduction of moisture content in sample prior to extraction [7].

Fouda using cold pressing, oil extraction yield increased and characterization of quality. The optimum conditions at pressing time was 180 min., oil productivity was 18.00%, and extraction efficiency were 98.46% at constant pressure [2].

Fish oils are a rich natural source of omega-3 polyunsaturated fatty acids (PUFAs), mainly Eicosapentaenoic acid (EPA) and Docosahexaenoic acid (DHA), which received great interest in the scientific community because of their positive roles on human health and nutrition [10].

Beneficial health effects of ω-3 PUFAs were well demonstrated and included the prevention of a number of diseases, such as coronary heart diseases, hypertension, arthritis, autoimmune disorders, cancer [1].

Kazuo Miyashita The benefit of fish oil to health has been widely recognized because of the high contents of

functional EPA (20:5n-3) and DHA (22:6n-3) in the oil; however, the application of fish oil has been limited by its high susceptibility to oxidation. This review reports the characteristics of EPA and DHA oxidation compared with those of other fatty acids such as linoleic acid (18:2n-6). In addition, effective approaches to protect against oxidation are discussed, focusing on the unique antioxidant potential of amine compounds. Finally, the exceptionally high oxidative stability of EPA and DHA in biological systems is discussed. Understanding the protective mechanism against EPA and DHA oxidation in such systems may be useful for the development of an effective antioxidant procedure for fish oil that is rich in EPA and DHA [4].

So the main objective to determine the amount of oil fish were extracted from fish waste resulted from butchering, cutting and splitting processes before salmon smoking by using cold pressing methods. Also avoid potential effects to the environment and human health.

2. Materials and Methods

Experiments were designed to extract fish oil from salmon waste before and after preparing for industrial processes and determined the oil extraction percentage from all By-products. The amount and the characteristics of extracted oil were tested at Regional Centre for food and feed the USDA Agricultural Research Center laboratory. The samples were used from fresh Salmon waste about 1000g from each of the (head, skin, viscera, backbone, frames and cuts off).

2.1 Salmon Sampling

Five salmon components group A, B, C, D and G according to weight 1.2, 1.5, 1, 7, 2.1 and 2.7 kg.

Table 1. salmon components groups.

Component	Salmon group				
	A	B	C	D	G
Head,	15	17	18.60	20.15	22
Skin	5	3.6	5.6	4.8	5
Off cuts	2	3	3.4	2.9	3
Trimming	10	9	7.2	8.7	8
Viscera	6	11	9	10.3	11
Backbone	8	7.6	11	9.6	9
Slice	54	48.8	45.2	43.55	42

Source: Author determination from Bentleys Egypt company

2.2 Salmon By-products

By-products are parts of the fish that are removed before

the fish reaches the final consumer in order to improve their keeping qualities, reduce the shipping weight or increase the value of the main fish product. They include blood, viscera, heads, bones, skin, trimmings and fins.^[8] The salmon fish components include water lose and fish by product percentage about 43.65%. edible portion nearly from 56.35% . While the fish waste percentage include (skin 5% - viscera 6% trimmings, 10% - off-cuts 2% - head 15% - backbone 8%). and salmon slice, 54%.

The salmon fish samples were collected from Bentleys Egypt company one from Egyptian industrial group, the by-products of befor and after salmon smoking, weighted 1000 grams for all component (head, off cuts, viscera, backbone frames, skin, and termning), separated and package under vacuum, as showing in Figure (1 to 5).



Figure 1. The salmon fish



Figure 2. The salmon skin

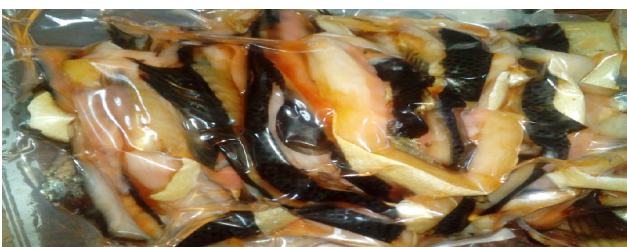


Figure 3. The salmon viscera and trimmings



Figure 4. The salmon head



Figure 5. backbone frames



Figure 6. The salmon slice

Source: Author determination Figure(1 to 5) from Bentleys Egypt company.

2.3 Cold Press Extraction

Cold press extraction were used required less energy also environmental friendly. High-quality oils can be obtained by performing production. It is used to extract oil from salmon waste samples waste samples prepared with using plastic bag under vacuum with 1 kg, from fish waste were processed to keep the waste material and put one bag in the pressing box have about 3 cm in deep, 30 cm in long, 15 cm in wide and two plate with the same dimensions one of them acting load on the sample's as a small prototype for cold pressing methods. Different compressed times from 20 to 200 min. at constant pressure were approximately.

2.4 Measurements

Oil weight (g) = Extract oil from fish by product sample (1000,g.)

Oil percentage recovery = the weight of oil recovered (g)/ the weight of the initial waste sample (g). *100

Oil productivity,% = Extract oil /Weight of fish by product × Average weight of fish.

Oil mass in sample determined three times for 1000 g. of Salmon by-products by cold pressing (cold pressing after 200 min.)

3. Results and Discussions

3.1 Salmon Components

The salmon components include salmon slice as edible portion and fish by product percentage as a industrial waste the results of edible portion and fish by product ranged from 42 to 54% and 46 to 56% respectively as

showing in Figure 7.

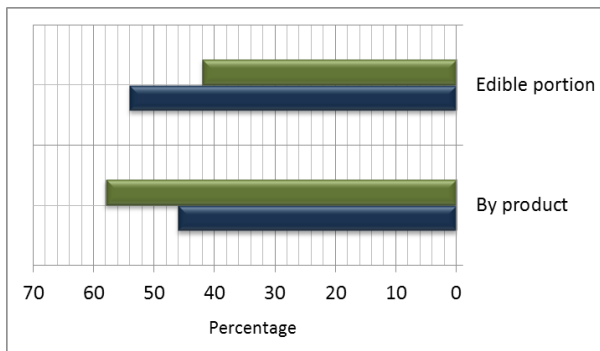


Figure 7. Salmon fish components

Source: Author determination

3.2 By-products Percentage

The fish waste percentage include head, skin, off-cuts, trimmings, viscera and backbone additional to salmon slice results in five salmon group A,B,C,D and G fluctuated with differences for all components as showing in Figure 8 and Figure 9.

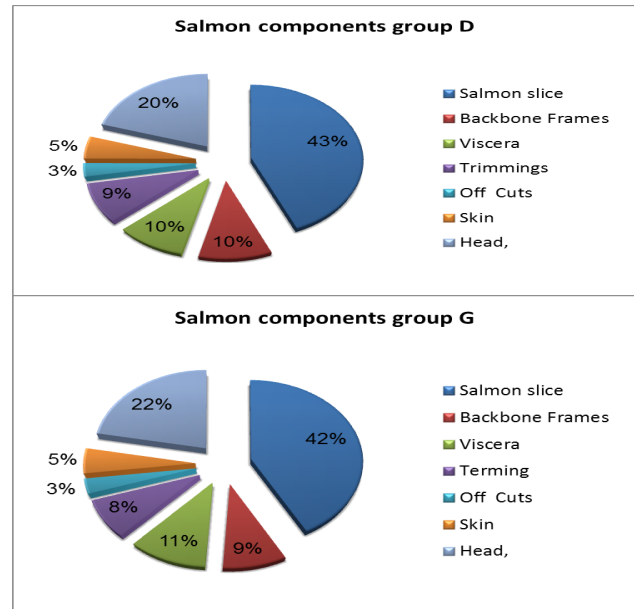
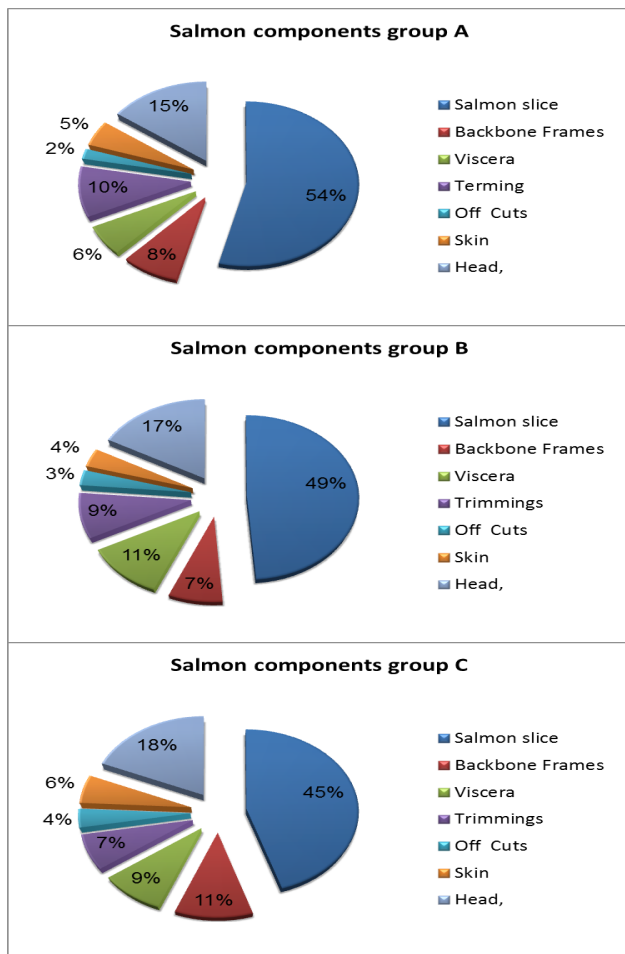


Figure 8. Five salmon components group A, B, C, D and G

Source: Author determination

The head ranged between 15 to 22%, skin ranged between 3 to 5.6%, off-cuts, ranged between 2 to 3.4% trimmings ranged between 7.2 to 10%, viscera ranged between 6 to 11% and backbone ranged between 7.6 to 11%. Also salmon slice ranged between 42 to 54%, this results recorded from different batches and result fluctuation accrued to fish preparing processes.

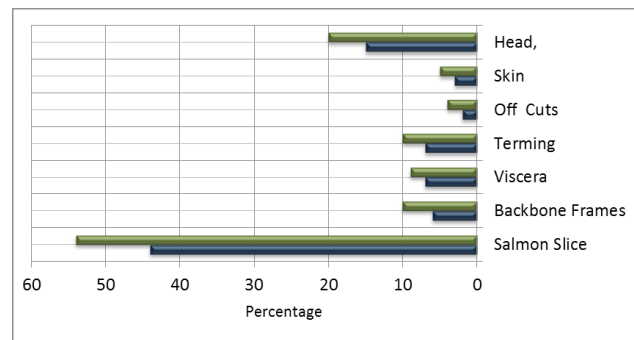


Figure 9. fluctuation in Salmon slice and by product components (cold pressing after 200 min.)

Source: Author determination

3.3 Oil percentage Recovery from By-products

Figure 10 Showed the oil percentage recovery from skin, ranged from 18.10 to 21%, head ranged from 17 to 19% viscera from 15.2 to 17.8% and terming from 16.0 to 18.8% this accumulated to fat percentage in salmon by product.

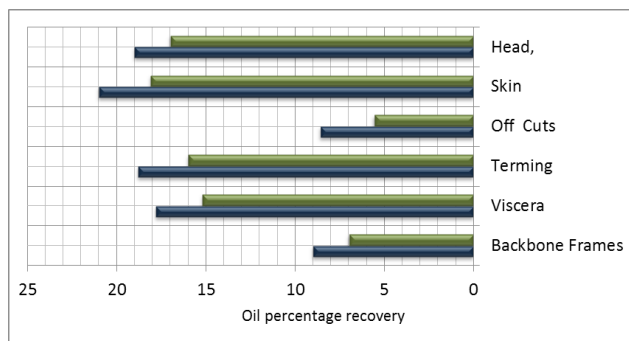


Figure 10. Oil percentage recovery from salmon by products (cold pressing after 200 min.)

Source: Author determination

3.4 Oil productivity from by products

Figure 11. Showed the oil productivity extracted from skin, the amount of oil ranged from 181 to 210 g. oil/1000g_{skin}, the amount of oil from head ranged from 170 to 190 g. oil/1000g_{head}, viscera from 152 to 178 g. oil/1000g_{viscera} and terming from 160 to 188 g. oil/1000g_{termining} according to fat percentage in by product, also the methods of extract and extract efficiency work as important factor.

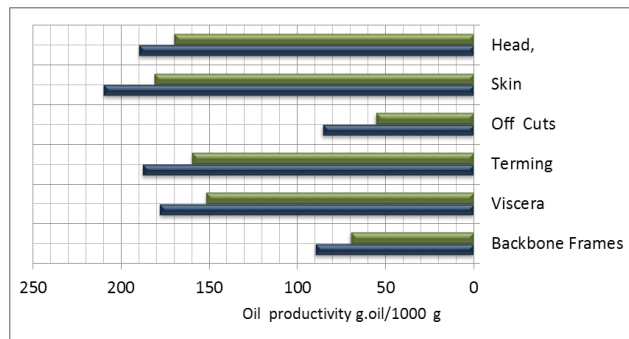


Figure 11. The amount of oil extracted from by products (cold pressing after 200 min.)

Source: Author determination

3.5 Oil extracted Characteristics from Salmon by Products

Salmon by products were extracted by cold pressing its content of long chain omega-3 polyunsaturated fatty acids (PUFA), such as (DHA), (DPA) and eicosapentaenoic acid (EPA), which are currently highly valued for their prophylactic and therapeutic properties in nutritional and health fields. High contents of functional EPA (20:5 ω 3) and DHA (22:6 ω 3) in the oil as showing in Table 2 and 3.

Table 2. Oil extracted components from salmon by products

Fatty acid	% of Total fatty acids	Estimated uncertainty (U)
Palmitic Acid C16:0	9.08	±0.31
Stearic Acid C18:0	2.51	±0.22
Oleic Acid C18:0	41.75	±1.66
Linoleic Acid C18:1n9	13.62	±2.43
Linolenic Acid C18:3n3	5.64	±0.24

Source: Author determination by Regional Centre for food and feed the USDA Agricultural Research Center laboratory.

Table 3. Oil extracted characteristics from salmon by products

Fatty acids	Name	Relative distributions
C14:0	Myristic acid	2.36%
C15:0	Pentaenoic acid	0.18%
C16:1ω9	Palmitoleic acid	0.28%
C16:1ω7		2.68%
C16:2ω4		0.38%
C17:0	Heptadecanoic acid	0.15%
C16:3ω4	Hexadecatrenoic acid	0.28%
C18:1ω7	Vaccinic acid	3.14%
C18:3ω4		0.16%
C18:4ω3	Octadecatetraenoic acid	0.58%
C20:0	Arachidic acid	0.32%
C20:1ω11	Octadecatetraenoic acid	0.29%
C20:1ω9	Gadoleic acid	4.16%
C20:1ω7	Eicosanoic acid	0.13%
C20:2ω6	Eicosadienoic acid	1.16%
C20:3ω6	Eicosatrienoic acid	0.17%
C20:4ω6	Eicosatrienoic acid	0.19%
C20:3ω3	Eicosatrienoic acid	0.52%
C20:4ω3	Eicosatrienoic acid	0.78%
C20:5ω3	Eicosapentaenoic acid(E-PA)	2.46%
C22:1ω11	Cetoleic acid	2.52%
C22:1ω9	Erucic acid	0.40%
C22:5ω3	Clupandonic acid(DPA)	1.12%
C22:6ω3	Docosahexanoic acid(DHA)	2.97%
None identified fatty acid		0.02%

Source: Author determination by Regional Centre for food and feed the USDA Agricultural Research Center laboratory.

3.6 Fatty Acids Composition

The results in Table 2 and 3 indicated that, total saturated

fatty acids (TSFA) in from salmon by products were 44% of total fatty acids (TFA). The major saturated fatty acids is palmitic acids (C16:0) which represented about 9.08% of TFA and about 58.51% of TSFA. The second one is myristic acid (C14:0) 3.26% followed by stearic acids (C18:0) 2.51% of TFA. Monounsaturated fatty acids (MUSFA) of oil extracted from salmon is 55.35% of TFA and the predominant MUSFA is oleic acids (C18:1n7) which is represented 41.75% of TFA and about 75.43% of MUSFA, followed by gadoleic acids (C20:1n7) 4.61% of TFA and 7.52% of MUSFA and vaccenic acid (C18:1n7) 3.14% of TFA and 5.67% of MUSFA. Polyunsaturated fatty acids (PUSFA) represent about 30% of TFA. The predominant PUSFA is linoleic acid (C18:2n6) which represent 13.62% of TFA and about 45.40% of PUSFA followed by five fatty acids represent more than 1.0% of TFA and between 1.12 – 5.64% of TFA, namely linolenic acids (C18:3n3) 5.64%, docosahexaenoic acid (C22:6n3, DHA) 2.97%, eicosapentenoic acid (C20:5n3, EPA) 2.46%, eicosadienoic acid (C22:2n6) 1.16% and clupanodonic acid (C22:5n3) 1.12% of TFA. Other PUSFA represent less than, the oil extracted from salmon had high amounts of MUSFA and PUSFA, these types of FA represented more than 85% of TFA, also this oil contains high amounts of w3, w6 and w9 fatty acids. These fatty acids play very important jobs in healthy nutrition.

4. Conclusions

The main results of the present research can be summarized as follows:

(1) The results of edible portion and fish by product ranged from 42 to 54% and 46 to 56% respectively.

(2) The salmon by product percentage classified to head ranged between 15 to 22%, skin ranged between 3 to 5.6%, off-cuts, ranged between 2 to 3.4% trimmings ranged between 7.2 to 10%, viscera ranged between 6 to 11% and backbone ranged between 7.6 to 11%.

(3) The oil fish salmon extracted from by product were oil percentage recovery from skin, ranged from 18.10 to 21%, head ranged from 17 to 19% viscera from 15.2 to 17.8% and tering from 16.0 to 18.8%.

(4) Oil extracted characteristics

Oil were extracted by cold pressing have high contents of functional EPA (20:5 w3) and DHA (22:6 w3) in the oil

References

- [1] Eslick G. D., Howe P. R., Smith C., Priest R., Bensoussan A. Benefits of fish oil supplementation in hyperlipidemia: a systematic review and meta-analysis. *International Journal of Cardiology*, 2009, 136: 4-16.
- [2] Fouda, T.Z. Waste Management For Smoking Salmon By- Products To Extract Omega-3 Fish Oil Scientific Papers Series Management, Economic Engineering in Agriculture and Rural Development, 2018, 18(3). Print ISSN: 284-7995, E-ISSN: 2285-3952.
- [3] Ghaly, A. E., Dave, D., Brooks, M. S., Budge, S. M.. Production of biodiesel by enzymatic transesterification: A critical review. *American Journal of Biochemistry and Biotechnology*, 2010, 6: 54-76.
- [4] Kazuo Miyashita. Prevention of Fish Oil Oxidation *Journal of Oleo Science* Copyright ©2019 by Japan Oil Chemists' Society doi: 10.5650/jos.ess18144J. *Oleo Sci.*, 2019, 68(1): 1-11.
- [5] Khoshmanesh, S.. Design of Solar Dehydrator, Coupled with Energy Storage in Rock Bed Reservoir for Fish Drying Process. *International Conference on Energy and Environment (ICEE)*, Universiti Tenaga Nasional, Bangi, Selangor, Malaysia, 2006, 28-30: 1-8.
- [6] Lin, C. Y., Li, R. J.. Fuel properties of biodiesel produced from the crude fish oil from the soapstock of marine fish. *Fuel processing technology*, 2009, 90(1): 130-136.
- [7] Mbatia B., Adlercreutz D., Adlercreutz P., Mahadhy A., Mula F., Mattiasson B.. Enzymatic oil extraction and positional analysis of ω -3 fatty acids in Nile perch and salmon heads. *Process Biochemistry*, 2010, 45: 815-819.
- [8] Ramirez, A.. Salmon by-product proteins *FAO Fisheries Circular*. 2017, 1027: 1-6.
- [9] Rustad, T.. *Physical and Chemical Properties of Protein Seafood by-products*. CRC Press, 2007.
- [10] Saldanha L. G., Salem Jr. N., Brenna J. T.. Workshop on DHA as a required nutrient: overview. *Prostaglandins, Leukotrienes and Essential Fatty Acids*, 2009, 81: 233-236.
- [11] Uitterhaegen E., Evon P.. Twin-cold extrusion technology for vegetable oil extraction: A review, *Journal of Food Engineering*, 2017, 212: 190-200.
- [12] Rome, FAO. 2007: 31. ISSN: 0429-9329. <http://www.fao.org/3/a-a1394e.pdf>