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RESEARCH ARTICLE

An economic study of fish production and consumption in Egypt and its role in food security achieving

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Abstract

The utilization of fish to produce healthy fish fillet and different materials with good nutritional and economic uses is a promising and an attractive business for both tilapia and catfish in Egypt. This article presents an analysis of the development of the international trade and fish consumption in Egypt, with calculation of (available for consumption, food gap, self-sufficiency, average per capita). In addition to measuring the marketing efficiency according to the sales methods and marketing channels for each of the tilapia and catfish by estimating the marketing margins and the distribution of consumer pounds. Finally, the by-products quantity expected to be obtained from both tilapia and catfish was calculated when these fish types process to fish fillet. The results showed that, the development of the quantity available for consumption reached the minimum in 2015 with a quantity of 2120.61 thousand tons, while the maximum amount was in 2016 by 2563, 00 thousand tons. The fish food gap and the fish self-sufficiency rate in Egypt fluctuated between increase and decrease between 2015 and 2020. As for the per capita consumption of fish, it reached about 16.80 kg/year as a maximum in 2019.
Also, the marketing efficiency fluctuated between a maximum and a minimum during the study period, for both tilapia and catfish and recorded the maximum in 2019. The results showed that there are large quantities of by-products can be obtained from both tilapia and catfish in the case of good processing and exploitation of these fish types.

Keywords: Local production; Import and export quantity; fish food gap; marketing efficiency; fish by-products.

1. Introduction

Fish meal is considered one of the most important traditional components of Egyptian citizens food recipe, as it is a source of low-cost protein. Fish as food, fishing industry, aquaculture, and fish farming are all economically important, however its recreational importance include fish keeping, leisure fishing and angling. Fish meals are an important economic source of protein compared to other animal protein sources. Fish accounts for over 30% of total animal protein consumption per capita in developing countries (Wang *et al.*, 2015).

The majority of fish farms in Egypt, are located in the Nile Delta region and located mainly in the Northern lakes (Maruit, Edko, Burullus and Manzala) (FAO, 2010). The largest portion of catched fish comes from the northern lakes, included El-Manzala, El- Borollos, Maryot and Edko lakes, with a total surface area of 1430 km2, (Samy-Kamal, 2015) reported that; the Mediterranean Sea and the Red Sea follow in second and third place, respectively.

The Nile tilapia (*Oreochromis niloticus*) is one of the authentic species cultivated commercially because of its good growth and vast potentiability

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for intensive farming (Melo *et al.,* 2013). Carcass and flesh quality have gained more attention among consumers and aquaculture industries because of its directly relation to human health and nutrition. The growth of tilapia production multiplied distinctly in the last four years, following the release of the genetically improved Nile tilapia strains to Egyptian farmers. Farm experiments comparing enhanced strains to commercial cultivars, found that better strains had a 28 % higher harvest weight and a 30 % quicker growth rate (Dickson *et al.,* 2016; Ibrahim *et al.,* 2013; Marjanovic *et al.,* 2016).

(El Mahdi *et al.,* 2015) indicated that farmed tilapia markets in Egypt have grown increasingly varied, with various grades of product sold at various rates depending on size, quality, location, and market. Information on the processing yield might be very useful for fish quality control and the tracing system, resulting in an increase in processing chain profitability (Galvão *et al.,* 2010).

Fish filleting is an important process in the preparation of much superior fish meat than dealing with entire fish (Hussein, 1990). Fish skin, collagen from inside the skin, fishmeal, and fish oil are all by-products of tilapia fillet manufacturing (Fitzsimmons, 2008).

(Caruso *et al.,* 2015) estimated that more than 50% of fish tissues are discarded as by-products. annually, induced about 20 million tonnes of by-products, that include fins, heads, skin, and viscera. As well as, one of the most appealing features characterizing the seafood industry, is the highly content of valuable protein (10–25%) which encouraged the utilization of seafood by-products, which are discarded and represented a growing issue.

Fish by-products can serve an extensive variety of purposes. As Heads, frames and fillet cut-offs and skin can be processed into fish sausages, cakes, snacks. Small fish bones, with a minimum amount of meat, are consumed as snacks or used directly as food in some Asian countries. As well as, are used in the production of feed biodiesel and biogas, dietetic products (chitosan), pharmaceuticals (including oils), natural pigments, cosmetics and ingredients in other industrial processes. Some species are commonly used for leather and gelatin include as shark, salmon, ling, cod, hag fish, tilapia. Fish skin, in particular from larger fish used in many industries such as clothing, shoes, handbags, wallets, belts and other items. On the other hand, fish collagens are used in cosmetics and in extraction of gelatin.

Fish viscera and frames are a source of value-added products such as bioactive peptides, used in food supplements and in biomedical and nutraceutical industries. Unfortunately, some by-products, especially viscera, are dramatically perishable. (Senevirathne and Kim, 2012).

(Silva and Dean., 2001) mentioned that whole and dressed catfish is further processed into traditionally utilizable forms, like, regular fillets, shank fillets, fillet strips, and nuggets. Processing of Catfish resulting in production of a large amount of fish waste or by-product, about 55% – 65% of the whole fish. Depending on produced products, by-product could accounted for more than 60% of the harvested weight of the fish, which are consist of varying amounts of heads, viscera, frames, skin, and few amounts of blood and fins (Crapo and Bechtel, 2003; Yin *et al.,* 2010). Recently, by-product from larger processing operations of Catfish is combined and sold to rendering plants, where by-products are utilized to produce protein meals and oils as an ingredients in fodder industry.

Factors, such as size, age, sex, anatomic shape of the body, head size and weight of viscera, skin and fins are effected on fillet and carcass yields. As well as, efficiency of fillet machine and expertise in handling are aspects that should be considerd. Processors have interest in knowing proximate composition of fish in order to predicted nature of the raw material before

cooling freezing smoking or canning and applied correctly (FAO, 2004)

This study aims to assess the current situation of fish production and consumption in Egypt and its role in achieving food security. In addition to calculating of the by-products amount that may produce during fish processing and clarifying the economic and nutritional value of these by-products.

2. Materials and Methods

2.1. Data entry and analysis

The data was collected, compiled and calculated from:

The Central Agency for Public Mobilization and Statistics, "Annual Bulletin of Fish Production Statistics", various issues.

The Central Agency for Public Mobilization and Statistics, "Annual Bulletin of the Movement of Production and international Trade and Available for Consumption", various issues.

Central Agency for Public Mobilization and Statistics, "Annual Bulletin of Food Prices and Services (Producer/Wholesale/Consumer)", various issues.

Central Agency for Public Mobilization and Statistics, "Annual Bulletin of Food Prices and Services (Producer/Wholesale/Consumer)", various issues.

The data was then analyzed to generate the outputs presented in this work as follow:

2.1.1. Development of international trade and fish consumption in Egypt

Available for consumption = (amount of domestic production + imports) - exports

Food gap = Amount available for consumption - Amount of local production

Self-sufficiency = the quantity of domestic production / the quantity available for consumption x 100

Average per capita = Available consumption / Population

2.1.2. Marketing efficiency measurements according to sales methods and marketing channels for the most important types of fish in Egypt

2.1.2.1. Marketing Margins

Marketing margins were calculated as the difference between the price charged by the producer and the price paid by the consumer.

2.1.2.2. Consumer pound distribution

These equations have been used to calculate the consumer pound distribution were as follow:

Share of the farmer = (farm price / retail price) x 100

Retailer's share = (Retail Price - Wholesale Price / Retail Price) x 100

Wholesaler's share = (wholesale price - farm price / retail price) x 100

2.1.2.3. Marketing Efficiency

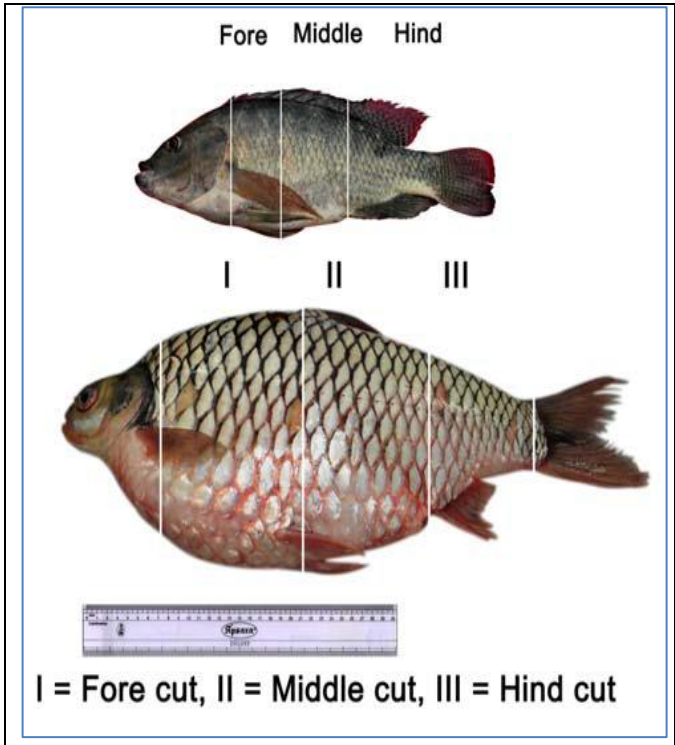
The following equation was used to measure it

Marketing efficiency = -100 (retail price - farm price) / retail price x 100

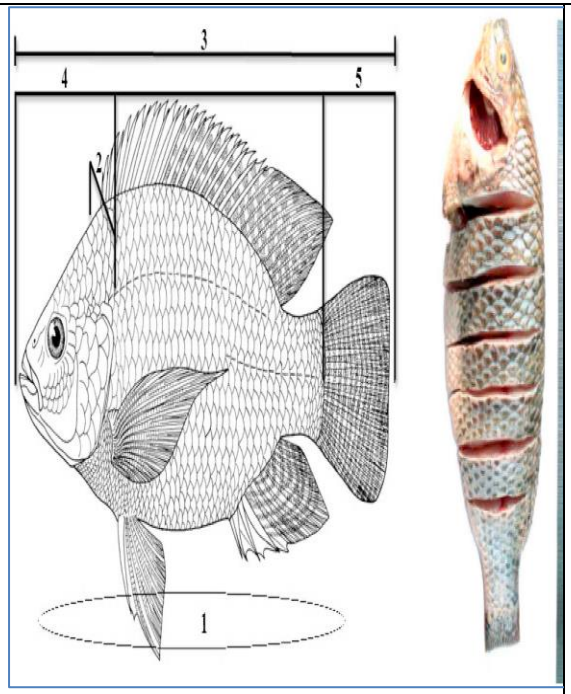
2.1.3. Evolution of the produced quantity of the most important types of fish and their by-products in Egypt during the period 2015- 2019.

2.1.3.1. Measurement of morphometric trait variables of tilapia were calculated as described in the previous studies.

2.1.3.2. Measurement of morphometric trait variables of catfish were calculated as described in the previous studies



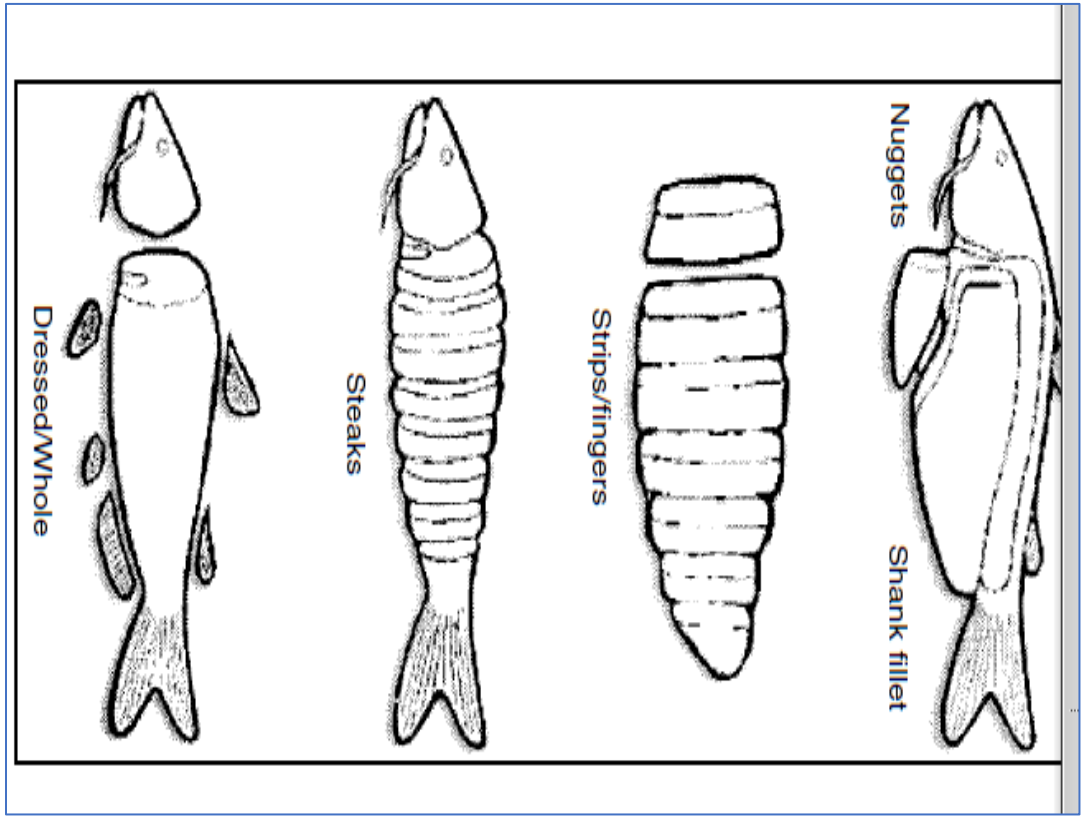
Morphological sites of three cuts, *Oreochromis niloticus* (top) and *Puntius goniotus* (bottom) Sahu *et al.* (2017).



Interview picture aids (source: adapted by author from *(*Hassanien *et al.,* 2011; Kosai *et al.,* 2014; Rocha *et al.,* 2012; Bogard *et al.,* 2018).

Offal yield traits	***Oreochromis niloticus***
Live weight (g)	819.1
Head (%)	27.1 10.7
Fins and tail (%)	5.5 1.5
Digestive tract (%)	11.3 20.0
Omental fat (%)	1.9 6.8
Scales (%)	2.6 3.5
Gill (%)	2.5 1.0
Skin (%)	1.4
Bone (%)	9.8

The percentage of Offal trait yields (*Oreochromis niloticus*) of the fish calculated as by-products according to the anatomical structure of tilapia fish.



Catfish processing input-output chart illustrating a hypothetical product mix and Product forms for both fresh and frozen farm-raised catfish. as following (Bosworth *et al.*, 2004).

Trait	channel catfish
Total weight (g)	708.2
Head (%)	22.9
Viscera (%)	12.7
Carcass (%)	64.4
Skin-on-fillet (%)	51.5
Skinned fillet (%)	45.9
Visceral fat (%)	1.6
Skin (%)	5.6
Ovary (%)	1.2

The percentage of Offal trait yields of the fish calculated as by-products according to the anatomical structure of channel catfish

3. Results and discussion

Fish and fish products trading plays an essential role in promoting fish consumption and achieving global food security by connecting producers with distant markets for which local supplies could be insufficient.

3.1. Development of international trade and fish consumption in Egypt

Data in Table No. (1) indicates the development of international trade of fish, available amount for consumption, the food gap, self-sufficiency, and per capita consumption average of fish during the period (2015-2019). Where the average of fish production in Egypt was estimated by 1791,15 thousand tons, and the production increased from 1518.94 thousand tons in 2015 to round 2038.99 thousand tons as a maximum in 2019, the average amount of fish exported in Egypt reached to 29,54 thousand tons, and it amounted to 19,70 thousand tons in 2015 and to 31 thousand tons as a maximum in 2019.

Regarding to the evolution of the available quantity for consumption, its average amounted to 2,120,61 thousand tons, and ranged between 1795,24 thousand tons as a minimum in 2015 and 2563,00 thousand tons as a maximum in 2019.

Fish and fish products exporting are necessary to the economies of many countries and several coastal, riverine, insular and lacustrine regions.

Table 1. Development of international trade and fish consumption in Egypt during the period (2015-2019)

Years	local production quantity (thousand tons)	Export Quantity (Thousand Tons)	Import quantity (thousand tons)	Available for consumption (thousand tons)	Food gap of fish (thousand tons)	Self-sufficiency (%)	Average consumption per capita (4) (kg/year)
2015	1518.94	19.70	296.00	1795.24	276.30	84.61	12.50
2016	1640.00	32.00	220.00	1828.00	188.00	89.72	13.50
2017	1822.80	35.00	339.00	2126.80	304.00	85.71	14.50
2018	1935.00	30.00	386.00	2290.00	355.00	84.50	16.30
2019	2038.99	31.00	555.00	2563.00	524.00	79.55	16.80
Average	1791.15	29.54	359.20	2120.61	329.46	84.82	14.72

It is also clear from the data in the same table; fish food gap in Egypt fluctuated between increase and decrease, reaching to 188 thousand tons as a minimum in 2016 and then increased to 524 thousand tons as a maximum in 2019, and its average reached 329.46 thousand tons. While for the development of fish self-sufficiency rate in Egypt, the average was 84.82% during the same period, as it fluctuated between increase and decrease, the lowest value in 2019 was 79.55% and the highest value in 2016 was 89.72%

for the average of per capita consumption of fish in Egypt during the same period, it recorded 14.72 kg/year, and ranged between 12.50 kg/year as a minimum in 2015 and 16.80 kg/year as a maximum in 2019. As a result of population growth outpacing supplies, fish consumption per capita in Africa is expected to decline by 0.2 percent annually until 2030, falling from 9.8 kg in 2016 to 9.6 kg in 2017. Because of the high prevalence of undernourishment in Africa, the projected decline in per capita fish consumption raises food security concerns, plenary levels of fish consumption remains low (9.9 kg per capita in 2015), in Western Africa had a maximum level of it about 14 kg per capita, to a minor about 5 kg per capita in Eastern Africa, obvious growth was noticed in North Africa (from 2.8 to 13.9 kg between 1961 and 2015) (FAO, 2017).

Internationally, Fish and fish products trade presently accounts for more than 9% of overall agricultural exports (excluding forest products) and 1% of global commerce and world stock trade in value terms. Fish and fish products are among the most widely traded foods in the world today, with most nations reporting some level of

fish commerce. Within countries and across regions, progress toward food security varies dramatically. More than one out of every nine persons in the globe was predicted to be hungry between 2014 and 2016, with 13 percent of developing-region populations being undernourished. (FAO, IFAD and WFP, 2015).

3.2. Marketing efficiency measurements according to sales methods and marketing channels for the most important types of fish in Egypt.

3.2.1. Marketing Margins

Fish, in addition to nutrients source, helps to the food and nutritional security of disadvantaged people in developing nations by diversifying their livelihoods and generating revenue (Neumann *et al.*, 2014; Béné *et al.*, 2015).

The study of margins (marketing differences) is important to address marketing problems and to judge the efficiency of various operations in the commodity marketing. Marketing margin is defined as the difference paid by a certain marketing organization and the gotten price for the same amount of the commodity. By other meaning it is also the price of all the marketing services and functions performed by various marketing institutions, such as collecting, sorting, transporting and storage, so if this definition includes the whole marketing path, the marketing margin is defined as the difference between the price charged by the producer and the price paid by the consumer. The marketing margin appears in an absolute form and in a relative form, where the absolute form expresses the marketing margins in certain monetary units, while the relative form expresses the absolute marketing margin relative to the selling price. (Abdel Rahim *et al.*, 2009)

3.2.2. Consumer pound distribution

The distribution of the consumer's pound is defined as the distribution of the value of one pound of the final consumer price paid by that consumer and how it is distributed to the producer or the farmer, the wholesaler, the retailer, and the marketing functions and their share of this pound (Abdel Rahim and Ahmed, 2017).

3.2.3. Marketing Efficiency

The significant demand in the major importing countries and areas, as well as the range of current trading fish species, offer a natural incentive to trade in fish and fish products.

Marketing efficiency means carrying out marketing functions to the fullest at the right time and at the lowest possible marketing cost, as it is defined as the relationship between the inputs and outputs of marketing services. (Thomsen, 1997) It is achieved when the current marketing services are performed at a lower cost or the increase of these services by a percentage less than the rate of increase in marketing services with no increase in marketing costs. Table. (2) shows the price levels, absolute marketing margins, and the distribution of the consumer pound for tilapia during the period (2015-2020), as the average farm price amounted to about 22.32 LE/kg, and the average wholesale price was about 23.51 LE/kg. The average retail price was estimated at 29.02 LE/kg. It is noted that from the absolute marketing margins between the product price, the retail price and the wholesale price, the average absolute marketing margin amounted to 6.7 LE/kg, representing about 30.2% of the farm price. It was also found that the absolute marketing margin of the farmer was estimated at 1.19 LE/kg, which represented about 17.76% of the average absolute marketing margin, while the average percent of the wholesaler was 5.51 LE/kg, which represented 82.24% of the average absolute marketing margin during the same period.

An important measure of economic efficiency is the analysis of the distribution of the consumer's pound across the market stages of the marketing systems, because consumer demand is the main driver of demand in the previous stages in a free economy and according to the theory of derived demand (Dawood *et al.*, 2017). The distribution

of the consumer pounds was 76.91%, 4.10%, and 18.99%, respectively (refer to Table No. "2"). Based on the foregoing, it is clear that the farmer gets the highest return from distributing the consumer pound when he sells tilapia in the retail market. While the wholesaler gets a lower return. The consumer costs the marketing margins between the farms and the retail market, represented in the costs of transportation and preparation for marketing. When calculating the marketing efficiency of tilapia, it was found that the average marketing efficiency was about 76.90%, and the efficiency fluctuated between a maximum and a minimum. It reached its maximum limit in 2019 by 82.14%, while it reached its minimum level of 68.88% in 2020 during the studied period.

Table 2. price levels, absolute marketing margins, and distribution of consumer pounds for tilapia during the period (2015-2020).

Statement / Year	current prices			Absolute Marketing Margins		Consumer pound distribution%			Marketing Efficiency (%)
	farm price	Wholesale price	retail price	(Wholesale –farm)	(retail – Wholesale)	product share (%)	Wholesale share (%)	Retail share (%)	
2015	17.58	18.08	23.58	0.50	5.50	74.55	2.12	23.32	74.55
2016	17.81	18.31	23.81	0.50	5.50	74.80	2.10	23.10	74.80
2017	25.58	26.08	31.58	0.50	5.50	81.00	1.58	17.42	81.00
2018	22.78	23.27	28.77	0.49	5.50	79.18	1.70	19.12	79.18
2019	27.45	27.89	33.42	0.44	5.53	82.14	1.32	16.55	82.14
2020	22.69	27.44	32.94	4.75	5.50	68.88	14.42	16.70	68.88
Average	22.32	23.51	29.02	1.19	5.51	76.91	4.10	18.99	76.90

Data in Table. (3) shows, the price levels, the absolute marketing margins, and the distribution of the consumer pound for catfish during the period (2015-2020). The average farm price was 14.91 LE/kg, the average wholesale price was 15.42 LE/kg, and the average retail price was estimated at 17.04 LE/kg.

When studying the absolute marketing margins between product price, retail price and wholesale price, it is noted that the average absolute marketing margin amounted to 2.13 LE/kg, representing about 14.29% of the farm price. It was also found that the absolute marketing margin for farms was estimated at 0.51 LE/kg, which represents around 23.94% of the average absolute marketing margin, while the average share of the wholesaler was 1.62 LE/kg, representing around 76.06% of the average absolute marketing margin during the same period.

Recently, emerging economies in developing countries have been progressively importing higher-value species for local consumption. Exporting countries ' access to foreign markets is influenced by a number of variables. In some nations, structural issues might impair the quality of fish products, resulting in product loss or trouble marketing them.

An important measure of economic efficiency is the analysis of the distribution of consumer pounds across the market stages of marketing systems. Because consumer demand is the main driver of demand in its previous stages in a free economy and according to the theory of derived demand (Dawood *et al.,* 2017). The distribution of the consumer pounds was also shown at 87.50%, 2.99%, and 9.51%, respectively (refer to Table No. 3).

According to data in table 3, it is clear that the farmer gets the highest return of distributing the consumer's pound when he sells catfish in the

retail market, while the wholesaler gets a lower return. While the consumer costs the marketing margins between the farms and the retail market, represented in the costs of transportation and preparation for marketing.

When calculating catfish marketing efficiency of the period (2015-2020), it was found that the average marketing efficiency recorded 87.55%, and the efficiency fluctuated between a maximum and a minimum, reaching its minimum level (78.02%) in 2015, while its maximum in 2019 recorded 91,98%. This indicates the marketing efficiency of this type of fish increased until 2019 and then decreased again in 2020.

Table 3. price levels, absolute marketing margins, and distribution of the consumer pound for catfish during the period (2015-2020).

Statement / Year	Current prices			Absolute Marketing Margins		Consumer pound distribution%			Marketing Efficiency (%)
	Farm price	Wholesale price	Retail price	-Wholesale farm	Farm price	Wholesale price	Retail price	-Wholesale farm	Farm price
2015	9.76	10.26	12.51	0.50	2.25	78.02	4.00	17.99	78.02
2016	9.50	9.80	11.30	0.30	1.5	84.07	2.65	13.27	84.07
2017	17.90	18.18	19.68	0.28	1.5	90.96	1.42	7.62	90.96
2018	17.75	18.05	19.55	0.30	1.5	90.79	1.53	7.67	90.79
2019	18.34	18.47	19.94	0.13	1.47	91.98	0.65	7.37	91.98
2020	16.23	17.73	19.23	1.5	1.5	84.40	7.80	7.80	84.40
Average	14.91	15.42	17.04	0.51	1.62	87.50	2.99	9.51	87.55

3.3. Evolution of the produced quantity of the most important types of fish and their by-products in Egypt during the period (2015-2019).

The extension of fish processing is creating an increasing in quantities of residues and other by-products, which may represent up to 70 % of fish used in industrial processing (Olsen *et al.,* 2014). In the last decades, fish by-products were often discarded as waste or used directly as feed for aquaculture, livestock, pets or animals breeding for fur production or used in silage and fertilizers. Table No. (4) Shows the produced quantity in thousand tons of each of tilapia and catfish, in Egypt during the period (2015-2019). The quantity of fillets and byproducts produced from both fish species are shown in the same table as well., where the average quantity produced from Tilapia ranged between 22059 thousand tons as the lowest amount in 2015 and 24,432 thousand tons as the highest amount in 2018, it means that this quantity was reduced again in 2019. Regarding catfish, the produced quantity was estimated at 13,640 thousand tons in 2015 and 14,688 thousand tons in 2017, and it decreased again in 2018, but it rose again in 2019.

By calculating each of the expected fillets and by-products quantity of tilapia in the case of processing fish into fish fillets, the produced quantity ranged between (7720.65 to 8551.2 thousand tons) for fillet and between (14338.35 to 15880.80 thousand tons) for by-products. While it ranged between (5865.20 to 6315.84 thousand tons) for fillets and between (7774.80 to 8372.16 thousand tons) for by-products for catfish. These expected quantities were

calculated according to the anatomical structure of both tilapia and catfish, which determines the ratio of meat to each of (internal viscera, fins, head, skin and skeleton), which were called by products as approved by previous studies (Toppe *et al.*, 2007).

Skinless and boneless tilapia fillets could be processed from entire fish. The yield of these techniques has been reported to be in the range of 30-37 %, depending on the size of the fish and the trimming process. (Argue *et al.*, 2003) discovered that channel catfish (*Ictalurus punctatus*) fillet yields are 42.5 %. By-products are expected to account between 25 to 35 % of the volume of fishmeal and fish oil produced, however there are geographical variances.

Consequently, the most important types of fish produced in Egypt (tilapia and catfish), produce the quantities described above and considering to the expected increasing in the produced from both tilapia and catfish in Egypt in the following years in addition to considering the amount of byproducts that could be produced from other types of fish produced in Egypt. Egypt has huge amount of by-products with high economic and nutritional value, which should be directed in their right tracks for healthy and economical products production.

Chiefly Egypt occupies the first place in Africa in fish production, which opens new scopes for the workforce associated with the fish trade in Egypt. In various countries, the usage of fish by-products has been developed into an important industry, with a growing attention on their handling in a controlled, safe and hygienic way.

Table 4. Evolution of the produced quantity of the most important types of fish and their by-products in Egypt during the period (2015-2019).

Species / Years	Tilapia			Catfish		
	Total production (thousand tons)	Fillet yield (thousand tons)	By products (thousand tons)	Total production (thousand tons)	Fillet yield (thousand tons)	By products (thousand tons)
2015	22059	7720.65	14338.35	13640	5865.20	7774.80
2016	23131	8095.85	15035.15	14290	6144.70	8145.30
2017	23825	8338.75	15486.25	14688	6315.84	8372.16
2018	24432	8551.20	15880.80	14375	6181.25	8193.75
2019	23932	8376.20	15555.80	14681	6312.83	8368.17

4. Conclusion

In the present study, fish production increased during the period from 2015 to 2019, as well as the amount of fish exports increased during the same period, while the fish food gap in fluctuated between increase and decrease and the average per capita consumption of fish has increased during the same period. In regard to the marketing efficiency, it turns out that the farmer gets the highest return from distributing the consumer's pound when he sells in the retail market, while the wholesaler gets a lower return and the consumer costs the marketing margins between the farms and the retail market represented by in the costs of transportation and preparation for marketing for both tilapia and catfish. By calculating the expected amount of by-products which to could be obtained when tilapia or catfish be manufactured, it was found that these types of fish give large quantities of by-products with high

economic and nutritional value, which should be exploited well, so that the fish industry in Egypt becomes one of the most economically promising industries.

Authors' Contributions

All authors are contributed in this research.

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Institutional Review Board Statement

This research was carried out by agreement between the department of agricultural economics. faculty of agriculture, south valley university and the department of food and dairy science. faculty of agriculture, south valley university.

Data Availability Statement

All data sources are referenced in the text and no additional data is annexed.

Ethics Approval and Consent to Participate

This research is not applied to living animals.

Consent for Publication

Not applicable.

Conflicts of Interest

The authors declare that they don't have any conflict of interest

5. References

Abdel Rahim, H.O., Ismail, T.H. (2009). 'Economic and marketing efficiency of some non-traditional agricultural crops in the Arab Republic of Egypt', *Assiut Journal of Agricultural Sciences,* (40), pp. 236.

Abdel Rahim., Ahmed, H. (2017). 'Production, Marketing, and Consumption of Tilapia in Egypt', *The Egyptian Journal of Agricultural Economics,* 27 (4), pp. 1741.

Argue, B.J., Liu, Z., Dunham, R. A. (2003). 'Dress-out and fillet yields of channel catfish, Ictalurus punctatus, blue catfish, Ictalurus furcatus, and their F1, F2 and backcross hybrids.', *Aquaculture,* 228, pp. 81–90.

Béné, C., Barange, M., Subasinghe, R., Pinstrup-Andersen, P., Merino, G., Hemre, G.I., Williams, M. (2015). 'Feeding 9 billion by 2050 – putting fish back on the menu.', Food Security, 7, pp. 261–274.

Bogard, J.R., Marks, G.C., Wood, S., Thilsted, S.H., (2018). *'Measuring nutritional quality of agricultural production systems: application to fish production.',* Glob. Food Sec., 16, pp. 54–64. doi: 10.1016/j.gfs.2017.09.004.

Bosworth, B.G., Wolters, W.R., Silva, J.L., Chamul, R.S., Park, S. (2004). *'Comparison of Production, Meat Yield, and Meat Quality Traits of NWAC103 Line Channel Catfish, Norris Line Channel Catfish, and Female Channel Catfish × Male Blue Catfish F1 Hybrids',* Publications from USDA-ARS / UNL Faculty. Paper 521. http://digitalcommons.unl.edu/usdaarsfacpub/521

Caruso, G. (2015). 'Fishery wastes and by-products: A resource to be valorised.], *J. Fish. Sci.*, 9, pp. 80–83.

Crapo, C., Bechtel, P.J. (2003). *'Utilization of Alaska's seafood processing byproducts.',* In P. J. Bechtel (Ed.), Advances in seafood byproducts: 2002 Conference proceedings Anchorage, AK: Alaska Sea Grant, University of Alaska Fairbanks. pp. 105–119.

Dickson, M., Nasr-Allah, A., Kenawy, D., Kruijssen, F. (2016). 'Increasing fish farm profitability through aquaculture best management practice training in Egypt.', *Aquaculture,* 465, pp.172–178. doi:10.1016/j.aquaculture.2016.09.015

Dawood, M.M., Hassanin, T.M., Amer, M.G and Hamed, A.F. (2017). 'Marketing Efficiency of Orange Crop in Sharkia Governorate.', *Zagazig Journal of Agricultural Research,* 44(1), pp. 4.

El Mahdi, A., Krstic, J., Abdallah, A., Abdullah, H., Kantor, P., Valpiani, N. (2015). '*The Role of Farmed Fish in the Diets of the Resource-Poor in Egypt.',* pp. 1–44.

FAO, IFAD, UNICEF, WFP, WHO. (2017). *'The State of Food Security and Nutrition in the World 2017',* – building resilience for peace and food security. Rome, FAO

FAO, IFAD, WFP. (2015). *'The State of Food Insecurity in the World 2015',* – Meeting the 2015 international hunger targets: taking stock of uneven progress. Rome, FAO.

Fitzsimmons, K. (2008). *'Tilapia product quality and new product forms for international markets. In From the pharaohs to the future.',* Eighth International Symposium on Tilapia in Aquaculture. Proceedings. Cairo, Egypt, 12-14 October 2008 (pp. 1-10). AQUAFISH Collaborative Research Support Program.

Galvão, J. A., Margeirsson, S., Garate, C., Viðarsson, J.R., Oetterer, M. (2010). 'Traceability system in cod fishing.', *Food Control*, 21(10), pp. 1360-1366.

Hussein, A.A. (1990). *'Biochemical studies on fish by-products.',* M. Sc. Thesis,Faculty of Agriculture, Zagazig University, Egypt.

Hassanien, H.A., Kamel, E.A., Salem, M.A., Dorgham, A.S. (2011). 'Multivariate analysis of morphometric parameters in wild and cultured Nile tilapia *Oreochromis niloticus*.', *J. Arab. Aquac. Soc.,* 6, pp. 424–440.

Ibrahim, N.A., Zaid, M.Y.A., Khaw, H.L., El-Naggar, G.O., Ponzoni, R.W. (2013). 'Relative performance of two Nile tilapia (Oreochromis niloticus Linnaeus) strains in Egypt: *the Abbassa selection line and the Kafr El sheikh commercial strain. Aquac. Res.,* 44, pp.508–517. doi:10.1111/j.1365-2109.2012.03240.x.

Kosai, P., Sathavorasmith, P., Jiraungkoorskul, K., Jiraungkoorskul, W. (2014). 'Morphometric characters of Nile tilapia (*Oreochromis niloticus*) in Thailand.', *Walailak. J. Sci. Technol.,* 11, pp. 857–863.

Marjanovic, J., Mulder, H.A., Khaw, H.L., Bijma, P. (2016). 'Genetic parameters for uniformity of harvest weight and body size traits in the GIFT strain of Nile tilapia.', *Genet. Sel. Evol.,* 48, pp. 41. doi:10.1186/s12711-016-0218-9

Melo, C.C.V., Neto, R.V.R., Costa, A.C., Freitas, A.T.F., Freato, A.A., Desouja, U.N. (2013). 'Direct and indirect effect of measures and means morphometric on body yield of Nila tilapia, *Oreochromis niloticus* Actascientiarum', *Animal sciences,* 35(4), pp. 357-363.

Olsen, R.L., Toppe, J., Karunasagar, I. (2014). 'Challenges and realistic opportunities in the use of by-products from processing of fish and shellfish.', *Trends in Food Science & Technology,* 36(2) pp. 144–151.

Rocha, D.N., Simoes, L.N., Paiva, G., Gomes, L.C. (2012). 'Sensory, morphometric and proximate analyses of Nile tilapia reared in ponds and net-cages.', *Rev. Bras. Zootec.,* 41, pp. 1795–1799.

Sahu, B.B., Barik, N.K., Routray, P., Agnibesh, A., Paikaray, A., Mohapatra, S., Sundary, J.K. (2017). 'Comparative studies on carcass characteristics of marketable size farmed tilapia (*Oreochromis niloticus*) and silver barb (*Puntius gonionotus*).', *International Journal of Fisheries and Aquatic Studies,* 5(2), pp. 06-09.

Samy-Kamal, M. (2015). 'Status of fisheries in Egypt: Reflections on past trends and management challenges.', *Rev. Fish Biol. Fisher.,* 25(4), pp. 631–649.

Senevirathne, M. and Kim, S.K. (2012). 'Development of bioactive peptides from fish proteins and their health promoting ability.', *Advances in Food and Nutrition Research,* 65, pp. 235–248. doi: 10.1016/B978-0-12-416003- 3.00015-9

Silva, J., Dean, S. (2001). *'Processed Catfish: Product forms, packaging, yields and product mix.',* SRAC Publication No. 184. MSU Food and Fiber Center.

Neumann,C.G., Bwibo, N.O., Gewa ,C.A., Drorbaugh ,N. (2014). *'Animal source food as a food-based approach to improve diet and nutrition outcomes.',* 29. Thompson, B., Amoroso, L., eds.

'Improving diets and nutrition: food-based approaches. Rome, The Food and Agriculture Organization of the United Nations FAO and CABI. UK by CPI Group (UK) Ltd, Croydon, CR0 4YY. pp. 157-172.

Thomsen, F. (1997). 'Agricultural, Marketing', McGraw-Hill, BooK company, New York US.

Toppe. J., Albrektsen.S., Hope. B., Aksnes, A. (2007). 'Chemical composition, mineral content and amino acid and lipid profiles inbones from various fish species', *Comparative Biochemical and Physiology*, (146B), pp. 395-401.

Wang, Q., Cheng, L., Liu, J., Li, Z., Xie, S., De Silva, S.S. (2015). 'Freshwater aquaculture in PR China: Trends and prospects.', *Rev. Aquacult.*, 7(4), pp. 283–302.

Yin, H., Pu, J., Wan, Y., Xiang, B., Bechtel, P.J., Sathivel, S. (2010). 'Rheological and functional properties of catfish skin protein hydrolysates.', *Journal of Food Science*, 75, pp.11–17. doi:10.1111/j.1750-3841.2009.01385.x