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Supply Analysis of Supplementary Products in Poland

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Abstract:

Purpose: *The paper aims to conduct studies that will enable identifying the supplementary products' categories offered in the market and, in consequence, determining the structure of the supplementary product's market in terms of the supply of supplementary products in the market.*
Methodology: *The elaboration authors conducted studies in Poland covering all 86,849 products in the market from 2007 to 2019*. The studies featured a statistical analysis of the type, quantity, and dynamics of product registration in the market. The Kruskal-Wallis test was also conducted to demonstrate the distribution of submissions in terms of the identified supplementary product categories and structural similarity index.*
Findings: *The structure of the Polish supplementary products market was determined based on the conducted analysis. The distributions were determined, and the structural similarity indices were designated. Thereby, it was possible to obtain answers to the manufacturer's reactions to the demand for supplementary products reported by individual consumers.*
Practical Implications: *For many years, it is possible to observe increasing demand among individual consumers worldwide for such products as dietary supplements, fortified foods, and special purpose foods. There is a justified need to produce and consume such products. Hys has conducted studies that allowed to determine that the subject literature mainly presents the results of research on nutrition dietetics and medical dietetics and derivative. On the other hand, the subject literature on management sciences features results mainly concerning individual reasons and preferences of consumer decisions related to these products' consumption. Due to the above, the authors of the paper, by analysing the widespread phenomenon of supplementary products' consumption, propose expanding analyzing areas with a new perspective.*
Originality/Value: *The authors, by analyzing the widespread phenomenon of supplementary products' consumption, proposed expanding the research area with a new perspective. This especially concerns the manufacturers' perspective, including the analysis of the supplementary product market's growth dynamics.*

Keywords: *Dietary supplements, fortified foods, special purpose foods, supply, structure, market, statistical test, Poland.*

JEL: *M20, O11.*
Paper Type: *Research Paper*

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1. Introduction

The subject literature on supplementary products is extensive. However, it is necessary to note certain specific phenomena concerning the scope of the conducted studies and scientific publications on supplementary products and the trends of supplementary products' consumption and the market value globally.

Many researchers around the world are researching various areas of this field. Among the fields studied most often and leading to the publication of over 90% of the total number of publications on supplementary products, it is necessary to list, among others, the following: nutrition dietetics (Anderson *et al*., 2009; Williamson and Manach, 2005; Yao *et al.*, 2004; Liu, 2004; Higdon and Frei, 2003; Kondrup *et al*., 2003; Halvorsen et al., 2002), agriculture dairy animal science (Hristov *et al.*, 2013; Awad *et al*., 2009; Chilliard et al., 2003; Chilliard *et al*., 2001; Clare and Swaisgood, 2000; Chilliard *et al.*, 2000), food science technology (Andres *et al*., 2018; Peng *et al*., 2018; Prior *et al*., 2005; Davalos *et al.*, 2004; Higdon and Frei, 2003; Burdock, 1998), biochemistry molecular biology (Poti *et al.*, 2019; Banikazemi *et al*., 2018; Waterland and Jirtle, 2003; Zemel *et al*., 2000; Park *et al*., 1997; Ernster and Dallner, 1995), veterinary sciences (Yilmaz, 2019; Yi *et al.*, 2018; Shingfield *et al.*, 2013; Sun *et al.*, 2010; Bricknell and Dalmo, 2005; Chilliard *et al.*, 2000), pharmacology pharmacy (Kothari *et al.*, 2019; Real *et al.*, 2019; Byeon *et al.*, 2019; Boots, 2008; Balunas and Kinghorn, 2005; Urso and Clarkson, 2003), fisheries (Vogel *et al.*, 2018; Hoseinifar *et al*., 2017; Sun *et al*., 2010; Gatlin *et al.*, 2007), endocrinology metabolism (Kieliszek *et al*., 2019; Estruch *et al*., 2019; Newgard et al., 2009; Schulz *et al*., 2007), medicine general internal (Reynolds *et al.*, 2019; Zhao *et al.*, 2017; Boushey *et al.*, 1995), toxicology (Post *et al.*, 2019; Wu *et al.*, 2016; Gulcin, 2012; Burdock, 1998) and many others.

Therefore, researchers mainly focus on aspects concerning the ability to use natural and synthetic substances from the technical, medical, biochemical, etc. perspective in the supplementary product's market. On the other hand, the issue of managing supplementary products is referred to as marginally. Few related publications especially concern the following fields: economy (Freijer *et al.*, 2019; Royne *et al*., 2014; Mason *et al.*, 2011; France and Bone, 2005), business (Cong et al., 2020; Mason and Scammon, 2011; Bolton *et al*., 2008), sociology (Stevens *et al.*, 2020; Smith *et al.*, 2010; Addis *et al*., 2005), management (Toukabri *et al*., 2019; Ozcan and Gurses, 2018; Smaiziene and Vaitkiene, 2014), ethics (Outram and Stewart, 2015; Slashinski *et al.*, 2012; Ling, 2004) or business finance (Cleff *et al.*, 2018).

Simultaneously, the observation of global trends in terms of the supplementary products' consumption threshold warrants the study of the processes creating this threshold and other associated processes. Therefore, the authors attempted to identify the issue of the supplementary products' supply. The related analysis of subject literature allowed to determine that researchers focus on their studies on supplementary products' consumption, however, mainly take into consideration the

perspective of individual customers (Hys, 2020; Hys, 2019; Hys, 2018). Due to the above, the authors of the paper noticed the cognitive gap and decided to broaden the knowledge and, in consequence, conduct studies correlated with the widespread phenomenon of supplementary products' consumption; however, they also proposed to broaden the research areas with the manufacturers' perspective, i.e., supply perspective.

An analysis of the quantitative data enables identifying the upward trends in supplementary products' sales and the market value. The regions with the highest consumption of mainly dietary supplements in the light of international research constitute the so-called category I. These include European countries (mainly Italy, Russia, Germany, the United Kingdom, and France) and the USA and Canada. The sales volume exceeds EUR 100 million. The countries in Asia, Anatolia, Australia, and Oceania constitute category II, in which the value of the dietary supplements market is higher than EUR 100 million but lower than 100 million Euro. Africa and South America are a group of countries designated as category III, i.e., they represent countries in which the value of the dietary supplements market is lower than 10 million Euro (Mordor Intelligence, 2019). These trends are confirmed by the data published by commercial organizations in reports developed by companies monitoring this industry branch globally (Report, 2019 a, Report, 2019 b).

Considering the observed global trends, the authors attempted to analyze the supplementary product's market in detail concerning Poland, one of the European countries (Table 1).

Table 1. *Value of the dietary supplements market in Europe (in million Euro)*

Country	**2015**	**2020***	**Change**	**Population** in thousands	**Country**	**2015**	**2020***	**Change**	**Population** in thousands
Italy	1 424.2	1 601.5	177.30	60 627	Switzerland	93.0	92.7	-0.30	8 526
Russia	887.7	1 079.9	192.20	145 734	Austria	81.7	91.9	10.20	8 891
Germany	966.6	967.2	0.60	83 124	Ukraine	75.7	87.1	11.40	44 246
United Kingdom	737.0	755.2	18.20	67 142	Lithuania	45.4	50.6	5.20	2 801
France	683.8	724.8	41.00	64 991	Greece	30.1	43.4	13.30	10 522
Poland	**353.4**	**407.5**	**54.10**	**37 922**	Ireland	35.9	38.2	2.30	4 819
Norway	231.5	220.4	-11.10	5 338	Slovenia	33.8	36.6	2.80	2 078
Finland	201.2	207.4	6.20	5 523	Bulgaria	22.5	25.5	3.00	7 052
Sweden	181.5	199.3	17.80	9 972	Portugal	24.3	24.5	0.20	10 256
Belgium	193.6	194.0	0.40	11 482	Serbia	19.0	21.1	2.10	8 803
Spain	182.6	193.5	10.90	46 693	Belarus	15.5	17.2	1.70	9 453
Netherlands	142.1	169.2	27.10	17 060	Latvia	11.4	13.6	2.20	1 928
Hungary	116.6	136.3	19.70	9 708	Croatia	11.3	11.7	0.40	4 156
Turkey**	96.0	121.7	25.70	82 340	Bosnia and Herzegovina	9.2	11.3	2.10	3 324
Romania	72.2	101.8	29.60	19 506	Estonia	6.7	7.1	0.40	1323
Denmark	96.5	98.7	2.20	5 752	Georgia	6.1	6.8	0.70	4003

Czech Republic	84.7	96.1	11.40	10 666	Macedonia	3.7	4.4	0.70	2 083
*forecast; ** Even though 97% of Turkey lies in Anatolia, the available statistics on the value of the dietary supplements market classifies it as a European country.									

Source: *Own elaboration based on Statista Ltd.; International Statistics Yearbook 2019, Published by GUS, Warsaw 2020 (if a specific European country is not mentioned, it means that the supplementary products' consumption is lower than the minimum value provided).*

According to the forecasts, Poland's value of the dietary supplements market will reach EUR 407.5 million in 2020. Simultaneously, it is estimated that in comparison to 2015, the market's value will increase by 54.10 million Euro (Mordor Intelligence, 2019). The phenomena occurring in the given industry branch are directly translated into the Polish supplementary products market condition. Poland is ranked 9th in the countries' provided list (Table 1).

On the other hand, in terms of the value of the dietary supplements market, Poland is ranked 6th, which means that the value of the supplementary product's market ranks the country 3 positions higher on a per capita basis. Therefore, Poland has a larger consumption of supplementary products than countries with higher numbers of residents, especially Turkey, Spain, and Ukraine. In consequence, based on the analysis of statistical data, it can be stated that Poland is among the leading European countries in terms of the value of the supplementary product's market. The rapid growth of the global supplementary products branch results from the demand declared by individual consumers or the creation of the demand by the manufacturers. Simultaneously, the increased consumption of supplementary products is the driver for the competition between market leaders worldwide, who actively create, grow, and stimulate the demand for these products.

- The existing science publications present supplementary products' consumption from the consumers' perspective, but they omit the manufacturers' perspective. Therefore, the authors notice the research gap and will be conducting studies to determine the Polish supplementary products market structure, but with the focus on the supplementary products manufacturers' perspective. Due to the above, the following research questions have been developed:
- What product categories are classified in the supplementary market?
- How is the term of the supplementary market defined?
- What Polish consumers consume supplementary product categories? what is the supply for supplementary products in Poland, depending on the product categories in the studied period, and what is the variation in the supply?
- Is the variation of the number of submissions of supplementary products similar?
- What is the distribution of the number of supplementary products' registration in GIS to introduce the Polish market?

The questions constitute a starting point for the authors' studies and analyses, which are provided in the latter part of the paper.

2. Background

The term of the supplementary product's market and the product categories identifying the markets seem relatively obvious. Nevertheless, a detailed analysis demonstrated that there are many related ambiguities. About the above and due to the conducted studies, the term of the supplementary market and the type of products offered in it require a detailed interpretation (Hys, 2017). In the light of statutory regulations, supplementary products constitute agents that include dietary supplements, fortified foods, and special purpose foods (Polish Journal of Laws 2002 No. 239 item 2050). Dietary supplements are foodstuffs, the purpose of which is to supplement the normal diet, constituting a concentrated source of vitamins or mineral components, or other substances that demonstrate a nutritional or another physiological effect […], excluding products with medicinal properties within the meaning of the pharmaceutical law (Polish Journal of Laws; Dz. U., 2006 Nr 171 poz. 1225, ACT of 25 August 2006 on food and nutrition safety, Art. 3.1, 39).

On the other hand, fortified foods are foodstuffs, the production of which includes the addition of nutritional and other components, including, among others, the following: vitamins, mineral components (including trace elements, amino acids, necessary unsaturated fatty acids, dietary fibers, various herbs, and herbal extracts, should not be used in dietary supplements, the so-called E) (Regulation (EC) No 1925/2006, Art. 1, pt. 2). Special purpose foods feature groups of products. The basis for this classification is the type of recipients to which the food is addressed. In consequence, it includes special food categories, such as (Regulation (EU) No 609/2013): infant formulae and follow-on formulae, processed cereal products, and other foods for babies, special medical purpose foods, daily diet replacement foods, bodyweight control foods. Therefore, this foodstuff is an agent that, due to its special composition or preparation method, differs substantially from widely consumed foodstuffs and, according to the information specified on the packaging, is marketed to satisfy special nutritional needs for specific groups of recipients (Polish Journal of Laws; Dz. U., 2006 Nr 171 poz. 1225, ACT of 25 August 2006 on food and nutrition safety, Art. 3.1, 43).

As a result of the above deliberations, it is possible to attempt to define the supplementary market. The market consists of current and potential customers who need it and are ready to pay for supplementary products (Cambridge English Dictionary, 2020). In terms of economics and the organization management processes, it can be assumed that the supplementary market constitutes a term that abstractly refers to the transaction of purchase and sale of dietary supplements, fortified foods, and special purpose foods as well as to their pricing (Ellis, 1990, 6-7). Therefore, it refers to countless decisions made by manufacturers and consumers representing the market's supply- and demand-sides and jointly determines the prices of supplementary

products. On the other hand, in terms of institutional economics, it can be assumed that the supplementary market is created by a set of mechanisms that exist to facilitate the exchange, coordination, and allocation of resources required to produce these products and of the supplementary products between the buyers and vendors (in a B2C market) as well as between manufacturers and intermediaries (in a B2B market) (ADB-DFID, 2005, 4). It can therefore be assumed that for the manufacturers, the supplementary market is an actual or nominal place in which the value of supplementary products is determined because of a clash of supply and demand forces.

3. Methodology

The scientific intentions announced in the title of this paper were accomplished by using qualitative and quantitative studies. By analyzing the widespread phenomenon of supplementary products' consumption worldwide and the scientific problems explored hitherto by researchers around the world, the authors of the paper proposed expanding the research area with a new perspective. It especially includes the supplementary market analysis in terms of management sciences and the manufacturers' perspective. Due to the above, the paper aims to conduct studies that will enable identifying the supplementary products' categories offered in the market, analysis of the market variation, and, in consequence, determining the structure of the supplementary product's market in terms of the supply of these products in the market. To achieve their aim, the studies were conducted in two stages. The first stage featured a systematic review of the subject literature, constituting of the following steps.

I. Initial analysis an identification of the study’s aim, including:
- specification of the research questions,
- search for topical subject literature coherent with the defined research aim,
- application of content analysis techniques to identify and
- interpret the issue, development of results in the scope of theoretical analysis.

The subject literature was generated mainly based on licensed international science databases, such as Scopus and Web of Science. The analysis covered solely English papers published in the databases until 14 March 2020. A filtering criterion for the dietary supplements phrase was applied. Then, the publications' topic was determined based on the generated reports. The focus was mainly on determining the studies' status on the supplementary product's market in management sciences. The study allowed for selecting publications on management sciences, which then underwent a detailed analysis of the contents specified in their titles, abstracts, or key words.

The next step featured a review, analysis, and verification of abstracts, thereby narrowing the publications' base to those with contents corresponding to the defined research aim. The topical literature analysis constituted the basis for the studies conducted in the next stage. The second stage of the studies featured quantitative analyses of the range of supplementary products submitted for registration in Poland in the State Sanitary Inspectorate (GIS) from 2007 to 2019* (*until day 02.12.2019).

According to the Polish law, enterprises that market supplementary products in the Republic of Poland for the first time are obliged to file a notification in the GIS (Polish Journal of Laws; Dz. U., 2006 Nr 171 poz. 1225, ACT of 25 August 2006 on food and nutrition safety, Art. 29, 1). The supplementary products subject to registration include dietary supplements, fortified foods, and special purpose foods for infants, babies, persons requiring special medical attention, and foods supplementing the daily diet. In the studied period, GIS received 86,849 submissions of products for registration. This data was used to create a database, for which complete studies were conducted. At this stage, the study procedure consisted of the following steps.

II. Designation of the Polish supplementary market structure, especially:
- Creation of own database containing 86,849 entries in STATISTICA program based on the GIS database, covering the period of 2007-2019* (It is necessary to note that the data for 2019 were analyzed in the scope of 11 months and were up-to-date as of 2 December 2019; in the paper, this is tagged by*).
- Identification of the supplementary products' classification categories.
- Identification of the supplementary product categories offered in the Polish market. Initial analysis of the type, quantity, and variation over time in the registration of supplementary products in the Republic of Poland for the first time in 2007-2019*.
- Determination of the supplementary products' supply structure in Poland. Analysis of the type, quantity, and variation over time in terms of supplementary product categories in the market.
- Determination of the supplementary market structure in Poland. Comparison of the variation in the number of submissions in 2007-2019* using the structural similarity index. Analysis of the distributions of the number of supplemented products submitted for registration by GIS for the first time in the Polish market. Making a research hypothesis that the distributions of the studied supplementary product submissions are the same. The verification of this hypothesis featured the use of the non-parametric Kruskal-Wallis test (Koziarska, 2010).

The conducted studies allowed for the identification of the supplementary products' categories offered in the market, conducting an analysis of the market variation and, in consequence, determining the structure of the supplementary product's market in terms of the supply of these products in the market.

4. Results

The studies were conducted to obtain answers to the research questions specified in the paper. The studies on the identification and specification of the definition of product categories in the supplementary market and the supplementary market term, conducted by the authors, constituted the basis for the issue's recognition in empirical studies. The study covered all supplementary products submitted by entrepreneurs for registration to the GIS in Poland. As a result of the conducted studies, all the registered products were identified and grouped into the following three product categories: dietary supplements (S), fortified foods (FF), special purpose foods (SPF).

4.1 Supplementary Product Categories Offered in the Polish Market

The initial analysis of the type, quantity, and variation over time in the registration of supplementary products in the Republic of Poland in 2007-2019* allowed for the following observations. The developed quantitative and percentage share list of all supplementary products' registration submissions filed for the first time in the Republic of Poland includes data concerning certain years (Table 2).

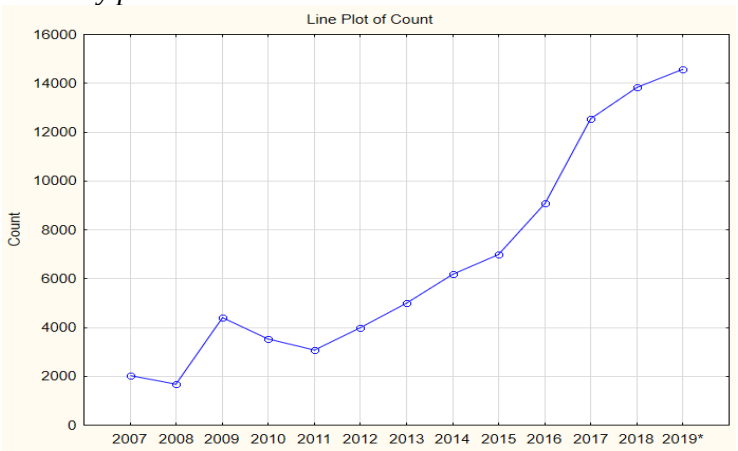
Table 2. *Total number of supplementary products' registration in Poland*

Category	All Groups Frequency table Count	Cumulative Count	Percent	**Cumulative Percent**
2007	2016	2016	2,32	2,32
2008	1687	3703	1,94	4,26
2009	4388	8091	5,05	9,32
2010	3521	11612	4,05	13,37
2011	3070	14682	3,53	16,91
2012	3996	18678	4,60	21,51
2013	4989	23667	5,74	27,25
2014	6174	29841	7,11	34,36
2015	6974	36815	8,03	42,39
2016	9072	45887	10,45	52,84
2017	12546	58433	14,45	67,28
2018	13834	72267	15,93	83,21
2019*	14582	86849	16,79	100,00
Missing	0	86849	0,00	100,00

Source: *Own creation.*

The illustration of the variability of the total number of supplementary product submissions in Poland for 2007-2019* is presented in figure 1 in a graphical form.

Figure 1. *Graphical illustration of the variability of the number of submissions of all supplementary products*



Source: *Own creation.*

The development of the quantitative and percentage share list featuring the division of all supplementary products into 3 separate categories, i.e., dietary supplements (S), fortified foods (FF), and special purpose foods (SPF), included the selection of all 86,849 data (Table 3).

Table 3. *Number of supplementary product submissions in Poland with division into supplementary product categories*

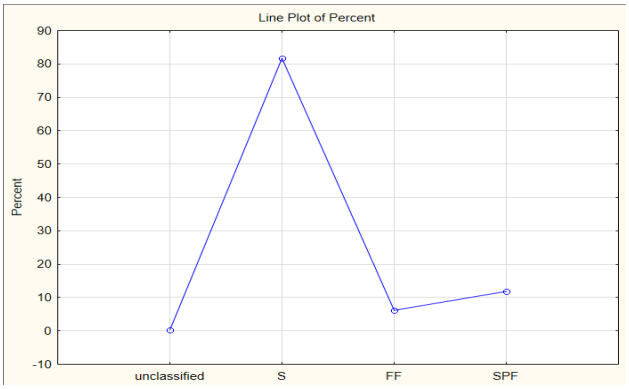
	Frequency table			
Category	Count	Cumulative Count	Percent	**Cumulative Percent**
unclassified	219	219	0,25	0,25
S	70965	71184	81,71	81,96
FF	5387	76571	6,20	88,17
SPF	10278	86849	11,83	100,00
Missing	0	86849	0,00	100,00

Source: *Own creation.*

The database featuring all supplementary product submissions in Poland from 2007 to 2019* includes many products that did not have the required labels and identifiers. Therefore, table 3 features the "unclassified" category. The category constitutes 0.25% of the total data.

Figure 2 presents the graphical illustration of the percentage share list for dietary supplements (S), fortified foods (FF), and special purpose foods (SPF). The chart also considers the category of supplementary products unclassified in the database. Because the "unclassified" category constitutes only 0.25% of all submissions, it was omitted in further analyses.

Figure 2. *Graphical illustration of the percentage share for supplementary product categories*



Source: *Own creation.*

The variation in the number of submissions in the period of 2007-2019* was studied by calculating the single-basis indices, in which the adopted basis was the number of submissions in 2007 and chain indices. The results are provided in Table 4.

Table 4. *List of individual indices for the number of supplementary product submissions in Poland*

Year	number of submissions	single-basis indices	chain indices
2007	2016	1,00	-
2008	1687	0,84	0,84
2009	4388	2,18	**2,60**
2010	3521	1,75	0,80
2011	3070	1,52	0,87
2012	3996	1,98	1,30
2013	4989	2,47	1,25
2014	6174	3,06	1,24
2015	6974	3,46	1,13
2016	9072	4,50	1,30
2017	12546	6,22	**1,38**
2018	13834	6,86	1,10
2019*	14582	**7,23**	1,05

Source: *Own creation.*

Summing up the studies on the general characterization of Poland's supplementary market, the authors made the following establishments. In the studied period, i.e., 2007-2019*, entrepreneurs submitted 86,849 registration applications to GIS for supplementary products marketed for the first time in the Republic of Poland. It was established that the number of supplementary product submissions in the Polish market in 2007-2019* has a clear upward trend (Figure 1). When analyzing years, it can be noted that the number of submissions is increasing continuously since 2007 (Table 4). In 2008, the single-basis index was lower than 1, while the chain indices are lower than 1 only in 2008, 2010, and 2011. The highest variation in the number of submissions can be observed in 2009, and the chain index of 2.6 means that a 160% increase was observed compared to the year prior. In 2019*, when compared to 2007, the number of submissions increased by as much as 623%, which is indicated by the single-basis index of 7.23.

In the next stage of analysis, all submissions were classified into three supplementary product categories, i.e., dietary supplements (S), fortified foods (FF), and special purpose foods (SPF). Among all submissions, 219 were not classified in any of the categories, regardless of the database's lack of adequate identifiers. As mentioned above, these submissions were designated as "unclassified." Among all submissions made by the entrepreneurs, the number constitutes 0.25% of the total data. The number is of marginal significance for the studied issue, so it was omitted in further analyses. On the other hand, a detailed data analysis allows for the conclusion that submissions

classified as dietary supplements constitute supplementary products' dominant category. This concerns 70,965 submissions, constituting 81.71% of all submissions to GIS in the studied period (Table 3).

4.2 Supply of Supplementary Products in Poland

Detailed analyses were conducted to precisely determine the share and significance of particular supplementary product categories. The analysis concerning the identification of quantitative and type-related trends in the supply of supplementary products in the Polish market was conducted (Table 5).

Table 5. *Number of submissions of dietary supplements (S), special purposes foods (SPF) and fortified foods (FF) in 2007-2019**

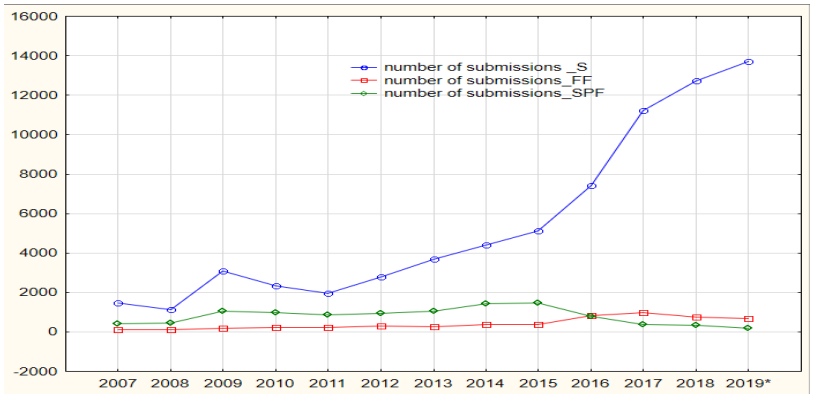
Year	S				FF				SPF			
	Count	Cumulative Count	Percent	Cumulative Percent	Count	Cumulative Count	Percent	Cumulative Percent	Count	Cumulative Count	Percent	Cumulative Percent
2007	1456	1456	2,05	2,05	95	95	1,76	1,76	431	431	4,19	4,19
2008	1116	2572	1,57	3,62	114	209	2,12	3,88	447	878	4,35	8,54
2009	3068	5640	4,32	7,95	204	413	3,79	7,67	1062	1940	10,33	18,88
2010	2317	7957	3,26	11,21	215	628	3,99	11,66	981	2921	9,54	28,42
2011	1970	9927	2,78	13,99	222	850	4,12	15,78	865	3786	8,42	36,84
2012	2767	12694	3,90	17,89	289	1139	5,36	21,14	920	4706	8,95	45,79
2013	3697	16391	5,21	23,10	245	1384	4,55	25,69	1036	5742	10,08	55,87
2014	4392	20783	6,19	29,29	367	1751	6,81	32,50	1413	7155	13,75	69,61
2015	5116	25899	7,21	36,50	382	2133	7,09	39,60	1459	8614	14,20	83,81
2016	7432	33331	10,47	**46,97**	832	2965	15,44	**55,04**	774	9388	7,53	**91,34**
2017	11204	44535	15,79	**62,76**	976	3941	18,12	**73,16**	359	9747	3,49	**94,83**
2018	12719	57254	17,92	**80,68**	764	4705	14,18	**87,34**	345	10092	3,36	**98,19**
2019*	13711	70965	19,32	**100,00**	682	5387	12,66	**100,00**	186	10278	1,81	**100,00**

Source: *Own creation.*

Table 5 presents the quantitative and percentage share list concerning the submissions of supplementary products by entrepreneurs in 2007-2019* for supplementary product categories, i.e., dietary supplements (S), fortified foods (FF), and special purpose foods (SPF).

Figure 3 presents, in a graphical illustration, the number of submissions of supplementary product categories 2007-2019*. Such a presentation of results will enable the comparison of the variation in particular categories.

Figure 3. *Number of submissions of supplementary product categories in the period of 2007-2019**



Source: *Own creation.*

Table 6 presents chain indices that confirm the variety in the variation in the submitted supplementary products for categories.

Table 6. *Chain indices for submissions in the studied categories in 2007-2019**

Year	Chain indices (S)	Chain indices (FF)	Chain indices (SPF)
2007	-	-	-
2008	0,77	1,20	1,04
2009	2,75	1,79	2,38
2010	0,76	1,05	0,92
2011	0,85	1,03	0,88
2012	1,40	1,30	1,06
2013	1,34	0,85	1,13
2014	1,19	1,50	1,36
2015	1,16	1,04	1,03
2016	1,45	2,18	0,53
2017	1,51	1,17	0,46
2018	1,14	0,78	0,96
2019*	1,08	0,89	0,54

Source: *Own creation.*

Table 7 presents the percentage shares of all supplementary product categories in the total number of all submissions made in 2007-2019*.

Table 7. *Percentage share of submissions of particular supplementary product categories in 2007-2019**

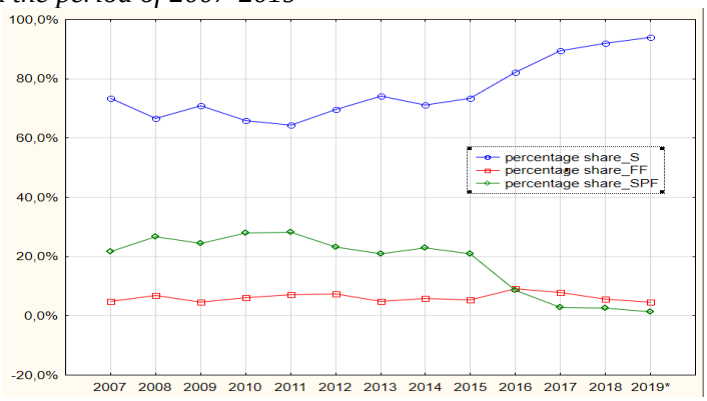
Year	Percentage share (S)	Percentage share (FF)	Percentage share (SPF)
2007	73,46	4,79	21,75
2008	66,55	6,80	26,65
2009	70,79	4,71	24,50
2010	65,96	6,12	27,92
2011	64,44	7,26	28,30
2012	69,59	7,27	23,14

2013	74,27	4,92	20,81
2014	71,16	5,95	22,89
2015	73,54	5,49	20,97
2016	82,23	9,21	8,56
2017	89,35	7,78	2,86
2018	91,98	5,53	2,49
2019*	94,05	4,68	1,28
Total in	**81,71**	**6,20**	**11,83**

Source: *Own creation.*

On the other hand, Figure 4 presents, in a graphical illustration, the percentage share of all submissions for particular supplementary product categories in 2007-2019*. Such a presentation of results will enable listing and comparing all categories and specifying their relations in percentages.

Figure 4. *Percentage share of submissions of particular supplementary product categories in the period of 2007-2019**



Source: *Own creation.*

Summing up the studies on the specification of supplementary products in Poland, the authors made the following establishments. The number of submissions of dietary supplements in the studied period increases, whereas the recent years featured over 50% of all submissions, specifically 53.03% registrations in 2017-2019*. On the other hand, the share of other supplementary product categories is smaller in recent years. In 2017-2019*, the submissions included 45% of fortified foods and only 9% of special-purpose foods (Table 5).

The analysis concerning the identification of quantitative and type-related trends in the supply of supplementary products in the Polish market in 2007-2019* demonstrated that dietary supplements feature an upward trend in the number of submissions throughout the entire studied period, excluding short-term drops in 2007-2008 and 2009-2011. On the other hand, this trend differs from other categories. The fortified foods featured an upward trend in the number of submissions in 2007-2017,

with a small drop in 2012-2013 and a downward trend in 2017-2019*. Simultaneously, the special purpose foods featured and an upward trend in the number of submissions in 2007-2015, with a small drop in 2009-2011 and a downward trend in 2015-2019* (Figure 3 and Table 6).

As a result of the obtained results, it can be stated that the variation in the number of submissions of all supplementary products in the Polish market is determined by the number of submissions classified in the dietary supplements category. Simultaneously, the studies "demonstSimultaneouslyhare" of dietary supplements in all submissions have a clear upward trend. From 2014, the trend is continuously Since easing, while in 2019,* the number of dietary supplements' submissions constitutes 94% of all submitted supplementary products. About the total number of registered supplementary products, the percentage share of dietary supplements amounted to 81.71%, followed by special purpose foods (11.83%) and fortified foods (6.20 %) (Figure 4).

4.3 Supplementary Product Market Structure in Poland

Two detailed analyses were conducted to determine the supplementary market structure in Poland. Firstly, the variation in the number of submissions was compared using the structural similarity index. An analysis of the distributions of the number of supplemented products submitted for registration by GIS for the first time in the Polish market was conducted. The comparison of the variation in the number of submissions was conducted using the structural similarity index. Table 8 presents the proportion of shares in the number of submissions in 2007-2019* for the 3 studied categories and all submissions. The list was obtained based on table 5 and on table 2 corrected using "unclassified" submissions.

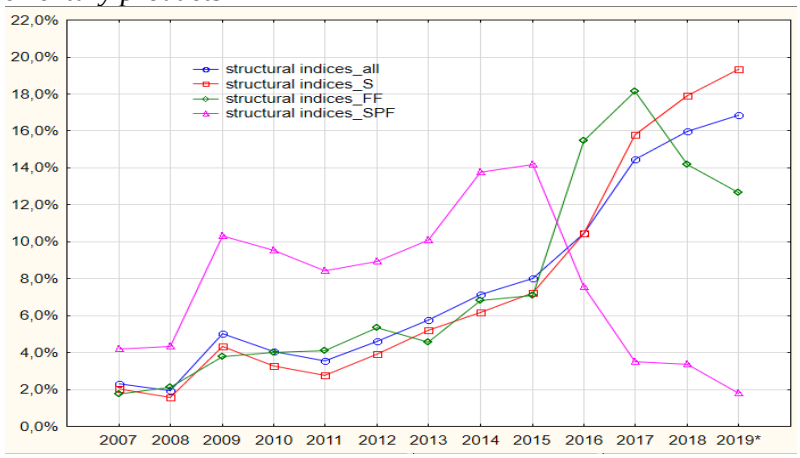
Table 8. *Proportion of shares in the number of submissions in 2007-2019**

Year	Proportion of shares for all **(%)**	Proportion of shares for **S (%)**	Proportion of shares for FF **(%)**	Proportion of shares for SPF **(%)**
2007	2,29%	2,05%	1,76%	4,19%
2008	1,94%	1,57%	2,12%	4,35%
2009	5,00%	4,32%	3,79%	10,33%
2010	4,06%	3,26%	3,99%	9,54%
2011	3,53%	2,78%	4,12%	8,42%
2012	4,59%	3,90%	5,36%	8,95%
2013	5,75%	5,21%	4,55%	10,08%
2014	7,12%	6,19%	6,81%	13,75%
2015	8.03%	7.21%	7.09%	14.20%
2016	10,43%	10,47%	15,44%	7,53%
2017	14,47%	15,79%	18,12%	3,49%
2018	15,96%	17,92%	14,18%	3,36%
2019*	16,83%	19,32%	12,66%	1,81%

Source: *Own creation.*

Based on data of Table 8, the proportion of shares for the number of submissions (structural indices) for the classifications taken into account and without classification ("all") in 2007-2019* is presented in Figure 5.

Figure 5. *Structural indices for particular supplementary products and in relation to all supplementary products*



Source: *Own creation.*

The interpretation of structural indices is as follows. The structure of the variation in the number of submissions of particular supplementary products is varied. A certain similarity can be observed for S and FF's structure, and there is a large similarity in the structure of the number of all submissions and dietary supplements (Figure 5).

The evaluation of this similarity was conducted using the structural similarity index ω_p defined with formula (1).

$$\omega_p = \sum_{i=1}^{k} min_i\left(\omega_{p_{1i}}, \omega_{p_{2i}}\right) \tag{1}$$

where $\omega_{p_{1i}}$ is the proportion (structural index) in the ith class for the 1st structure and $\omega_{p_{2i}}$ is the proportion (structural index) in the ith class for the 2nd structure.
The calculation of the structural similarity indices for the studied categories provided the following results:

ω_{p1}=88%, ω_{p2}=56%, ω_{p3}=53%,

where:
ω_{p1} - structural similarity Index for FF and S,
ω_{p2} - structural similarity Index for FF and SPF,
ω_{p3} - structural similarity Index for S and SPF.

Index ω_{p1}=88% indicates that the similarity in the variability of the structure of submissions for dietary supplements and fortified foods is high. The data presented in

Figure 6 allow for the conclusion that the similarity is even clearer finishing in 2017. In fact, the structural similarity index for S and FF amounts to 93% in 2007-2017.

The calculations also included the structural similarity indices of all submissions with the structures of submissions in particular classified categories, which resulted in the following:

$$\omega_{p4}=94\%,\ \omega_{p5}=90\%,\ \omega_{p6}=58\%,$$

where:
ω_{p4} - structural similarity Index for "all" and S,
ω_{p5} - structural similarity Index for „all" and FF,
ω_{p6} - structural similarity Index for „all" and SPF.

Because of the conducted analysis, it can be stated that the variation of all submissions and dietary supplements' submissions is very similar. The related structural similarity index amounts to 94%, which means that from 2007 to 2019*, the similarity in the variation of all submissions and dietary supplements' submissions is very high. Simultaneously, the share of dietary supplements in all submissions is the highest and amounts to 81.71%. In the same period, the similarity in the variation of all submissions and fortified foods' submissions is very high – the structural similarity index amounts to 90%. However, the share of fortified foods in all submissions is small and amounts to 6.2%. Table 9 featured a quantitative list of supplementary product submissions with consideration of the product categories. The data will designate the number of submissions in the Polish supplementary market in 2007-2019*.

Table 9. *Quantitative list of submissions of particular supplementary product categories registered in Poland in 2007-2019**

Year	List of submissions (S)	List of submissions (FF**)**	List of submissions (SPF)
2007	1456	95	431
2008	1116	114	447
2009	3068	204	1062
2010	2317	215	981
2011	1970	222	865
2012	2767	289	920
2013	3697	245	1036
2014	4392	367	1413
2015	5116	382	1459
2016	7432	832	774
2017	11204	976	359
2018	12719	764	345
2019*	13711	682	186
Total	**70965**	**5387**	**10278**

Source: *Own creation.*

It was hypothesised that the distributions in the number of the studied supplementary product submissions are the same. The verification of this hypothesis featured the use of the non-parametric Kruskal-Wallis test.

Let F_1 be the distribution function for the number of submissions of dietary supplements (S), F_2 – distribution function for fortified foods (FF), F_3 - distribution function for special purpose foods (SPF). With the significance level of α=0.05, the null hypothesis (H_0) takes the following form:

$$H_0: F_1(x) = F_2(x) = F_3(x), \text{ for every } x \in R.$$

The alternative hypothesis (H_A) is the negation of the null hypothesis, which means that at least two distributions differ:

$$H_A: \exists_i \exists_j \; i \neq j \; \wedge \; i,j \in \{1,2,3\} \; \wedge \; F_i(x) \neq F_j(x), \text{ for every } x \in R.$$

The test statistics' calculations were conducted in the STATISTICA program. The results are presented in Table 10.

Table 10. *Test statistics value – ANOVA Kruskal-Wallis Test*

	Kruskal-Wallis ANOVA Kruskal-Wallis test: H (2, N= 39) =27,53609 p =,0000		
Depend.:	Valid N	Sum of Ranks	**Mean Rank**
S	13	426,0	32,77
FF	13	126,0	9,69
SPF	13	228,0	17,54

Source: *Own creation.*

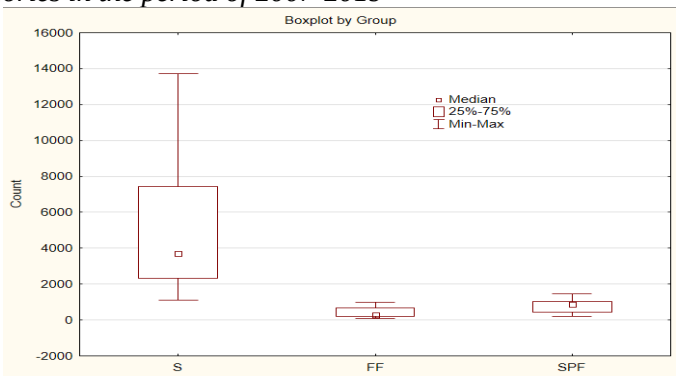
The test statistics $\chi^2_d \approx 27.54$ belongs to the test critical region, because $p \approx 0.00 < \alpha = 0.05$, i.e. the null hypothesis must be discarded in favour of the alternative hypothesis with an error of 0.05. The distributions of the number of submissions in the three tested categories differ substantially. Two homogenous groups were distinguished by using the non-parametric multiple comparisons test (Table 11).

Table 11. *Non-parametric multiple comparisons test*

	Multiple Comparisons p values (2-tailed); Kruskal-Wallis test: H (2, N= 39) =27,53609 p =,0000		
Depend.:	S R:32,769	FF R:9,6923	**SPF R:17,538**
S		0,000	0,002
FF	0,000		0,238
SPF	0,002	0,238	

Source: *Own creation.*

Figure 6. *The box and whisker plot of submissions of particular supplementary product categories in the period of 2007-2019**



Source: *Own creation.*

The first group only includes the S submissions, while the second group includes the FF and SPF submissions, which means that the FF and SPF submissions' distributions do not differ substantially.

5. Conclusion

Based on the conducted studies, it was established that the Polish supplementary market includes three product categories. These categories include the following: dietary supplements, fortified foods, and special purpose foods. Therefore, the supplementary market is defined by the product categories, and, in the manufacturer's perspective, it is an actual or nominal place in which the value of supplementary products is determined as a result of a clash of supply and demand forces. It was established because of the conducted studies that the number of supplementary product submissions in the Polish market in 2007-2019* has a clear upward trend. It must be noted that the highest variation in the number of submissions occurred in 2009 when the chain index amounted to 2.6, which means that it increased by 160% when compared to the year prior.

On the other hand, in general, it can be noted that the number of submissions in 2019* increased by as much as 623% when compared to 2007. It must be noted that 2019 was studied until 2 December 2019 (incomplete period). Consequently, it was established that dietary supplements are the dominant product category in the Polish supplementary products market. Detailed analyses allowed for establishing that in the last three years, the submissions of dietary supplements constituted over 50% of all submissions made by Polish entrepreneurs to GIS in the studied period. On the other hand, in general, the submissions of dietary supplements constituted as much as 81.71% of all submissions to GIS in the studied period. Similarly, the variation in the number of submissions indicates that the dietary supplements' supply is increasing. On the other hand, the supply is dropping for fortified foods and special purpose foods. In terms of the distribution of the number of submissions, the hypothesis that the

distributions in the number of the studied supplementary product submissions are the same, it was established that the null hypothesis must be discarded in favor of the alternative hypothesis. This means that the distributions of submissions in the three tested categories differ substantially. The non-parametric multiple comparisons test allowed for distinguishing two homogenous groups, with one including the number of dietary supplements' submissions and the other including the number of fortified foods' and special purpose foods' submissions. This means that the distribution of the number of dietary supplements' submissions differs substantially from the numbers of FF and SPF submissions.

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