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# Natural medical attributes and benefits of *Spirulina*: Segmentation based on consumers' knowledge

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**Consumers today are more health conscious and more interested in health related products than ever before. This behaviour has led to the production of natural products such as the commercial production of microalgae. Of all the blue-green algaes, *Spirulina* has received the greatest interest. *Spirulina*, a filamentous cyanobacterium is considered to be a wholesome natural source of nutrition, and is used for human food, animal feed, and in the cosmetics industry. The medicinal use of *Spirulina* is due to its nutritional properties. Previous research on *Spirulina* showed that it has numerous beneficial effects on human health. The purpose of this research was to describe a quantitative study (n = 795) in Thessaloniki, Greece which identified consumer segments based on their awareness of *Spirulina* and its medical benefits to human health. A further aim of the study was to explain the differences in awareness and level of knowledge of *Spirulina*'s beneficial role to health, on the basis of demographic and socioeconomic attributes. Two consumer segments were produced through K-means Cluster analysis, from the consumers that were aware of the *Spirulina* product (n = 343). These segments were tagged as "low knowledge consumer segment" and "moderate knowledge consumer segment". Results also showed that clusters were statistically significantly different regarding awareness, age, occupation, and net individual monthly income.**

**Key words:** *Spirulina*, health products, consumer awareness, knowledge, segmentation.

## INTRODUCTION

Over the last decades the population of Thessaloniki and of Greece in general has become fully westernized, deviating from the highly praised for its value traditional Mediterranean diet and adopting eating habits that prevail in the rest of the North and Western Europe and North America (eating more often out instead of eating meals prepared at home, choosing fast food and rich in fat food, easy to prepare meals such as pizzas and hamburgers over wholesome meals that are based on their variety of nutrients). Cardiovascular diseases, several types of cancer, high blood cholesterol levels etc., have since been on the rise, along with the use of dietary supplements (multivitamins, multiminerals, herbal remedies and *Spirulina*) that are thought to have a preventive action against the aforementioned diseases or conditions. *Spirulina*, a blue-green alga (Belay et al., 1993), has been used as a food source for centuries in areas of Asia, Africa and parts of South America (Carmichael and Stukenberg, 2006). Previous reports of Abdulqader et al. (2000) and Ciferri and Tiboni (1985) mentioned the use of *Spirulina* as a food in Mexico during the Aztec period, as

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well as by natives residing close to Lake Chad. Today, *Spirulina* is produced in more than 22 countries and is consumed in over 77 (IISMAN.org).

In Greece, *Spirulina* is produced by the Algae SA Company, established in 1996 in Therma, Nigrita in the prefecture of Serres. The company's investment took place in 1997 as a part of the European Programme LEADER (spirulina.gr). It consists of the only *Spirulina* producer in Europe (Kiriakidou, 2009). Up to the year 2008 the company had a growth rate of 200 to 300% per year, and is considered amongst the three world-wide companies that produce *Spirulina* in a green house, producing about 5000 kilos per year and possessing a 40% of the market share (Christopoulou, 2009).

Research on *Spirulina* showed that it has a 60 to 70% by weight protein content (Belay et al., 1993), and is considered as one of the richest protein sources in the plant kingdom (Layam et al., 2006). Furthermore, it is replete with vitamins, such as vitamin B12 and provitamin A, that is, β-carotene (Belay, 2002), it is a natural source of γ-linolenic acid (Sajilata et al., 2008; Belay et al., 1993), and it contains a number of other phytochemicals that are thought to exert beneficial effects on human health (Belay, 2002). In addition, it has been proven safe for human consumption (Belay, 2002; Salazar et al., 1996; Ciferri, 1983). *Spirulina* is used as a health food (Mazo et al., 2004), as animal feed (Ahsan et al., 2008), in the cosmetics industry (Li and Qi, 1997) and in the food industry for example, as a food additive (Mazo, 1999). It is used by NASA because of its health and nutritional benefits (Karkos et al., 2008) and the European Space Agency, in coordination with the French GEM11 Company, tested recipes with *Spirulina* for astronaut meals (Wagner, 2005).

Numerous studies have been conducted regarding *Spirulina*, with emphasis on production, uses, chemical/ nutrient composition, and health benefits. The medicinal use of *Spirulina* is due to its nutritional properties (www.samsonssecret.com). The health benefits associated with consumption of *Spirulina* include: Enhancement of the immune system (Hirahashi et al., 2002), antioxidant activity (Dartsch, 2008; Wu et al., 2005), anticancer effects (Dembitsky et al., 2006), antiviral effects (Babu et al., 2005), for example, Hépatites C (Tinnerello et al., 2001), and HIV treatment (Kwei et al., 2008), control of hyperlipidemia and cholesterol (Kaur et al., 2009), effects against hepatotoxicity (Abd El-Baky et al., 2009), obesity (Li and Qi, 1997), allergies (Cingi et al., 2008), arthritis, immune-modumation and inflammation (Kumar et al., 2010, 2009) and diabetes (Iyer et al., 1999). *Spirulina* also helps against heavy metal intoxications (Doshi et al., 2009), protects against radiation (Ruan et al., 1988), malnutrition (Simpore et al., 2006), and depression (Frazer et al., 2005). Lastly, it has positive ergogenic effects (Kalafati et al., 2009) and helps cure non-bloody diarrhoea (Bongco

et al., 2010).

Taking into consideration that *Spirulina* has many nutritional and health benefits, combined with the very limited studies regarding awareness of its medical attributes (for example, Kamenidou and Priporas, 2010), *Spirulina* deserves further research. Desai and Sivakami (2004) state that one factor inhibiting people from using *Spirulina* is a lack of awareness of the associated health benefits. In this context, this paper focuses on consumer segmentation based on the awareness level of *Spirulina* and knowledge of its attributes and health benefits. Because this research is exploratory in nature, four specific objectives were chosen for investigation:

1. Awareness of *Spirulina* by consumers from Thessaloniki, Greece (the second biggest city in Greece), with a population of approximately one million people.
2. Knowledge level of *Spirulina's* attributes and health benefits.
3. Underlying factors that predict knowledge of *Spirulina's* attributes and health benefits.
4. Consumer segments based on awareness level and knowledge of *Spirulina's* attributes and health benefits.

To address the aforementioned issues, a research approach was utilized as presented subsequently, following with the presentation of the research findings. This paper concludes with the discussion-conclusions, limitations and directions for further research.

## RESEARCH METHODOLOGY

### The survey instrument

The survey instrument used was a consumer questionnaire formulated by Kamenidou and Priporas (2010). Consumers awareness of the *Spirulina* product was measured on a 5 point Likert type scale marked: 5 = I am aware of the *Spirulina* product, and I purchase it on a regular basis, 4 = I am aware of the Spirulina product and I purchase it on an occasional basis), 3 = I am aware of the *Spirulina* product, I have purchased it once, and did not purchase it again, 2 = I am aware of the *Spirulina* product, but have never tried it, 1 = I am not aware of the *Spirulina* product. The question regarding consumers' knowledge of *Spirulina* attributes and health benefits was comprised of 32 items, measuring subjective or perceived knowledge (Brucks, 1986) on a 5 point Likert type scale, that is, a modified version of the knowledge scale used by Koivisto and Magnusson (2003).

### Data collection

Data reported in this paper was collected through field research on adult existing or potential consumers, which took place from early February until the middle of April 2009. The sample was selected using the mall interception technique (Malhotra, 2007; Chimboza and Mutandwa, 2007), via an aided self-completion questionnaire. The study targeted consumers in the city of Thessaloniki, Greece, the second largest city in the country. Prior to the survey, a pilot study of 34 consumers in this city had been undertaken. Participant

of the research could be any adult consumer (over 18 years of age) willing to participate in the study. The total sample size of usable questionnaires was 795, a sample size that was sufficient for the statistical analysis performed (Hair et al., 2005; Lehman et al., 1998).

It must be mentioned that under the existing time and economic constraints, the sampling method used was the only one feasible. The SPSS-17 software package was used to analyze sample data. Data analysis included frequencies, percentages, means, reliability, factor, cluster and chi-square statistics (cross tabulation analysis).

### Consumers' profile

Regarding gender, 53% were men and 47% were women. Age had six subcategories: 18 to 25 years old, 26 to 35, 36 to 45, 46 to 55, 56 to 65 and 65+ years of age, whereas one fourth of the sample fell in the age range of 26 to 35 years. More than half of the sample (56.6%) was married.

Also, 29.5% was single, 7.2% was divorced and 6.7% was widowed. In addition, 46.1% had children under the age of 18 in the household, and 53.9% did not. The distribution of the educational level of respondents showed that most respondents held at least a bachelor degree (41.8%) or were high school graduates (secondary education 30.7%). In addition 13.1% had primary education, 5.5% did not finish elementary school, and 8.9% had over-secondary education. Considering occupation, most respondents was employed in the private sector (23.4%) or was self-employed (20.5%).

Furthermore, 17.4% was a federal employee, 5.8% was labourers, 10.6% on pension and 22.3% was dependent economically from others (housewives, students, unemployed). Finally, as far as net individual monthly income was concerned, 19.8% fell in the income category "up to 600.00€"; 25.9% in the category 600.01 to 1000.00 €, 25.4% ranged from 1000.01 to 1500.00€, 13.8% in the category 1500.01 to 2000.00€, and 15.1% had an individual income more than 2000.01€.

## RESULTS AND DISCUSSION

### Awareness of the *Spirulina* product

On the 5 point Likert -type scale measuring awareness, results showed that 452 consumers (57%) were not aware of the *Spirulina* product. Regarding the rest of the sample (43%), 232 respondents (29.2%) answered that they were aware of *Spirulina* as a product, but had never tried it, 38 respondents (4.8%) were aware of the *Spirulina* product, had purchased it once, but did not proceed to repurchase, 5.4% (43 respondents) was aware of the product and purchase it on an occasional basis, while only 30 respondents (3.8%) not only were aware of *Spirulina* as a product, but also purchase it on a regular basis.

### Knowledge of *Spirulina* attributes and health benefits

### - Factor analysis

Respondents aware of the product (that is, 343

respondents) were asked to assess their knowledge level referring to *Spirulina* characteristics, as well as to its health benefit on the 5-point knowledge scale using 32 items. From it is apparent that knowledge levels are moderate as mean scores range from 2.50 to 3.62 for 30 out of 32 statements Table 1. The largest mean score was 3.94 for the general definition statement: "*Spirulina* is a microscopic filamentous blue-green alga, naturally growing in fresh water, which can even grow in sea water and is used as food supplement for humans". On the other hand, the statement with the lowest mean score of 2.07 was for: "It does not (*Spirulina*) contain any cholesterol"

Data derived from the 343 respondents of the knowledge question were factor- analyzed through Principle Component Factor Analysis with Varimax Rotation (Hair et al., 2005). This was employed in order to extract the underlying knowledge dimensions for a relatively smaller number of manageable size factors (Gumus and Koleoglu, 2002) which were then used for further analyses, that is, cluster analysis (Chuang et al., 2011; Arabatzis and Kyriazopoulos, 2010; Chimboza and Mutandwa, 2007).

Principle Component Factor Analysis with Varimax rotation identified four factors (K.M.O. = 0.960, B.T.S. = 8857.316, df = 496 p = 0.00) with Eigen values greater than one and communalities greater than 0.50. Keiser-Meyer-Olkin statistics of 0.960 and Barlett's test of Sphericity statistics of 8857. 316 indicated that data were appropriate for performing factor analysis (Norusis, 2000). All items had a loading of 0.50 or higher on one of these factors, illustrating a good fit (Hair et al., 2005) and accounting for 70.1% of the total variance. Reliability analysis showed that the Cronbach alpha indicator of the total scale (a = 0.9720), as well as for the four factors (a = 0.9438, 0.9311, 0.9007 and 0. 9136 for the first, second, third and fourth factor respectively) was considered satisfactory (Malhotra, 2007). (Table 1) summarizes the results of factor analysis, displaying the items, factor loadings, Eigen values, Cronbach's alpha coefficients and the communalities of each item. It also displays the factor's label named after the variables highest factor loading and according to the content of the variables per factor.

### Consumer segmentation

In order to perform customer segmentation, K-means cluster analysis was performed based on the extracted factors, following the procedure used by Kamenidou et al., (2009) and Nayak et al., (2003). The two-cluster solution was selected as the most appropriate, while cluster membership was as follows: cluster 1 = 186 respondents and cluster 2 = 156 respondents (Table 2). Due to missing values, one case was not positioned in

**Table 1.** Means and factors extracted on consumers knowledge of *Spirulina* attributes and health benefits.

| Question-Item | Means (StD) | Factor loading | Communalities |
|---|---|---|---|
| **1st factor: Natural, energetic, ideal for vulnerable groups food, 19.6% of the total variance explained, Eigen value = 18.3, MFS = 3.32 (St.D. = 1.00), a = 0.9438.** | | | |
| It contains natural nutrition components and not synthetic. | 3.62 (1.31) | 0.784 | 0.752 |
| It contains all the metals that we need: iron, magnesium, potassium, zinc and the trace element selenium (anticancer). | 3.48 (1.33) | 0.697 | 0.734 |
| It gives energy in those who are interested in maintaining a normal weight. | 3.34 (1.31) | 0.663 | 0.599 |
| It contains more from 100 beneficial nutritious elements, absolutely necessary for the human organism. | 3.34 (1.32) | 0.641 | 0.643 |
| It does not contain any cholesterol. | 2.07 (1.31 | 0.623 | 0.655 |
| Ideal food for vulnerable groups of people such as pregnant women and the elderly. | 3.17 (1.33) | 0.612 | 0.582 |
| It is one of the richest foods in the antioxidative provitamin A (β-carotene). | 3.24 (1.34) | 0.601 | 0.708 |
| It is a very good source of vitamins B12 and E. | 3.27 (1.29) | 0.569 | 0.739 |
| It can be also consumed as an additive in various foods (pasta, dairy products, juices, etc). | 3.24 (1.33) | 0.518 | 0.668 |
| Rich in chlorophyll, that is particularly beneficial for the development of red blood cells. | 3.19 (1.33) | 0.507 | 0.701 |
| Inhibits cholesterol from accumulating in blood vessels. | 2.96 (1.28) | 0.502 | 0.669 |
| It clears the blood from toxins and stimulates the function of all body tissues and organs, especially the liver, which has a key role in the removal of toxins. | 3.10 (1.26) | 0.507 | 0.654 |
| *Spirulina* is a microscopic filamentous blue - green alga, naturally growing in fresh water, which can even grow in sea water and is used as food supplement for humans. | 3.94 (1.01) | 0.504 | 0.621 |
| **2nd factor: *Spirulina's* microelement and vitamin contents,19.2% of the total variance explained, Eigen value = 1.99, MFS = 3.05 (St.D. = 1.05), a = 0.9311.** | | | |
| It is 3 times richer in vitamin E than raw wheat germ. | 3.11 (1.25) | 0.758 | 0.712 |
| It contains 28 times more iron than raw beef liver. | 3.04 (1.30) | 0.742 | 0.733 |
| It contains 25 times more β-carotene than raw carrots. | 3.14 (1.29) | 0.731 | 0.682 |
| Its content in vitamin B12 is 2 to 6 times higher than raw beef liver. | 2.93 (1.25) | 0.730 | 0.774 |
| Contains 58 times more iron than raw spinach. | 3.19 (1.26) | 0.712 | 0.708 |
| It has 49% better absorption than synthetic vitamin E | 2.89 (1.21) | 0.684 | 0.679 |
| It contains only 5% fat without any cholesterol, a large percentage of which is in the form of the essential for our health ω-6- lipid acids, mainly linoleic and γ-linolenic acid. | 2.98 (1.31) | 0.670 | 0.604 |
| It has 60 to 70% protein content. | 3.19 (1.29) | 0.534 | 0.635 |

**Table 1.** Contd.

| | | | |
|---|---|---|---|
| **3rd factor: *Spirulina's* antivirus, anticancer and anti-allergy effects,16.4% of the total variance explained, Eigen value = 1.34, MFS =2.58 (St.D. = 1.02) a = 0.9007.** | | | |
| It is effective against a number of viruses, including the HIV-1 virus, responsible for the AIDS disease. | 2.51 (1.22) | 0.790 | 0.705 |
| It helps in the reduction of allergic reactions. | 2.77 (1.25) | 0.722 | 0.713 |
| It protects against allergic rhinitis. | 2.59 (1.20) | 0.733 | 0.730 |
| Research showed that the consumption of 1 g/ day of *Spirulina,* completely eliminates the damage of the mucous membrane of the mouth. | 2.53 (1.15) | 0.708 | 0.670 |
| The *Spirulina* polyphenol extract inhibits the growth of hepatic tumours. | 2.50 (1.20) | 0.670 | 0.708 |
| **4th factor: Health protection attributes of *Spirulina,* 14.9% of the total variance explained, Eigen value = 1.28, MFS = 2.76 (St.D. = 1.05), a = 0.9136.** | | | |
| Has ω- 3 and ω-6 polyunsaturated fatty acids in GLA. | 2.71 (1.28) | 0.690 | 0.685 |
| It is rich in γ-linolenic acid, which is used from the body for the production of prostaglandin E1, which has a significant role in the regulation of our immune system. | 2.83 (1.26) | 0.666 | 0.726 |
| It is rich in γ- linolenic acid which is effective in controlling the premenopausal syndrome. | 2.55 (1.20) | 0.639 | 0.735 |
| It regulates body pH to 7.32 to 7.45 | 2.57 (1.16) | 0.624 | 0.669 |
| The contained amino acids protect our brain cells and improve the function of our neural system. | 2.84 (1.28) | 0.569 | 0.671 |
| It protects the cells from the action of free radicals, stimulates the production of blood cells and enhances our immune system. | 3.09 (1.27) | 0.567 | 0.680 |

Sample: 342. (K.M.O. = 0.960, B.T.S. = 8857.316, df = 496, p = 0.00). Total Cronbach Alpha: 0.9720, Total variance explained: 70.1%.

**Table 2.** Consumers segments based on knowledge factors.

| Knowledge factors | 1st cluster, n = 186 Low knowledge | 2nd cluster, n = 156 Moderate knowledge | F ratio and Significance levels |
|---|---|---|---|
| Natural, energetic, ideal for vulnerable groups food | 2.44 | 4.04 | F = 434. 547 (p = 0.000) |
| *Spirulinas'* microelement and vitamin contents | 2.32 | 3.44 | F = 496.090 (p = 0.000) |
| *Spirulina's* antivirus, anti-cancer and anti-allergy effects | 2.01 | 3.17 | F = 208.914 (p = 0.000) |
| Health protection attributes of *Spirulina* | 2.08 | 3.58 | F = 358.970 (p = 0.000) |

Sample size: 342.

any of the two clusters. The results of ANOVA test revealed internal validity of the cluster results, and also that all factors contributed to differentiate the two clusters (Saunders, 1994). In order for profile segments based on consumers' level of awareness of *Spirulina* as well as their socioeconomic characteristics, cross-tabulation analyses were conducted. Results showed that clusters were statistically significantly different regarding awareness ($\chi^2$ = 59.488, df = 3, p = 0.000), age ($\chi^2$ = 17.360, df = 5, p = 0.003), occupation ($\chi^2$ = 16.085, df = 7, p = 0.017), and net individual monthly income ($\chi^2$ = 15.799, df = 5, p = 0.007). The first cluster was compiled from 186 respondents, representing 54.4% of the total sample size. This segment had relatively low FCC, which in all cases was <2.50 and ranged between 2.01 to 2.44. This cluster was named the "low knowledge consumer

segment". In this segment, 85% was aware of the *Spirulina* product, but had never tried it, 7.5% had purchased it once, but did not purchase it again, 4.3% purchase it on occasional basis, and 3.2% purchase it on a regular basis. This cluster had equally distributed men and women, and the age of respondents ranged from 18 to 35 years (53.7%). More than a third of the segment are single (37%) with the highest level of education being up to secondary education (30.4%), 27% of the segment was dependent regarding profession (student, housewife or unemployed) and had a low- income, that is, 51% of the segment had a net monthly individual income less than 1000 €.

The second cluster was composed of 156 respondents, representing 45.6% of the total sample size, tended to be the moderate knowledge consumers. This segment had FCC that ranged from 3.17 (3rd factor) to 4.08 (1st factor). This cluster was named the "moderate knowledge consumer segment". In this segment, 46.8% was aware of the *Spirulina* product, but had never tried it, 15.4% had purchased it once but did not purchase it again, 22.4% purchased it on occasional basis, and 15.4% purchased it on regular basis. This cluster had equally distributed men and women. Age was equally divided in three main categories each one consisting of 23.7% (26 to 35, 36 to 45, 46 to 55 years old), being married (61.5%), and holding at least a bachelor degree (30.2%). In addition, 49.4% of the people consisting this cluster were employees (federal or private) having a monthly net individual income more than 1500.01€ (38%).

## DISCUSSION AND CONCLUSIONS

This study aimed to segment consumers in Thessaloniki Greece based on awareness of *Spirulina* and their knowledge of its attributes and health benefits. This was realized through field research. In this study it was found that more than the half of the sample was not aware of the product (first objective). In regard to the low awareness that consumers have of the *Spirulina* product, Pitts and Katsanis (1996) state that in order for a brand to have future sales and, moreover, a respectable market share, the managers' first job is to create and enhance brand awareness. Alerk and Settle (1999) in outlining strategies for building strong brand preferences, state that the first strategy is to develop "need association" through developing brand name awareness. The same can be said for product awareness. If product awareness is not developed, consumers will not purchase it. 57% of the respondents were not aware of *Spirulina*. This shows that further studies are needed to explore the reason why more than half of the sample population have no knowledge of *Spirulina* whatsoever. The results of such studies could be implemented in the marketing planning of *Spirulina* producers in Greece. Only 9% of the

respondents reported that they purchase *Spirulina* on an occasional or regular basis. It becomes evident that the percentage of Greeks who are aware of *Spirulina* and use it regularly is very small and there is a good prospection for the *Spirulina* industry in Greece.

Overall, Greek consumers have moderate knowledge of the products' attributes and its health benefits (second objective). This result is constant to the findings of Kamenidou and Priporas (2010), who found that consumers in Athens, Greece had also moderate knowledge of *Spirulina* medical benefits as well as *Spirulina* attributes. The third objective of the study was to find underlying factors that are associated with knowledge of *Spirulina* attributes and health benefits in order to produce a smaller number of variables for further analysis. This was accomplished through factor analysis with Varimax rotation. Results produced four factors accounting for 70.1% of total variance. The fourth objective of the study was to perform a first level segmentation through cluster analysis where clusters had different knowledge of the products' attributes and medical benefits. The results helped us identify two major subgroups among those who were aware of *Spirulina*, on the basis of the level of knowledge they had in regard with the beneficial role that *Spirulina* has on our health and especially its preventive action against diseases such as cancer, cardiovascular diseases and even AIDS. The first subgroup includes those who had low knowledge and the second those who had moderate knowledge.

The cluster named "low knowledge consumers" makes up for a 84.9% of the aware participants who had never tried *Spirulina*. They were people whose awareness did not trigger their interest in trying the product and could had less interest in healthy food, or may not believe that healthy food really exists. People in this cluster were probably not interested in healthy eating or generally in a healthy lifestyle.

These findings clearly imply that consumers need to be informed about the product and its medical benefits. This information about the product and its health benefits could either appear in the form of a nationwide advertisement campaign, or it might focus on opinion leaders, such as doctors and pharmacists. From the clusters, it is clear that there is a tremendous potential to increase its market share, since the use of the product is quite low and awareness of the products' impact on human health is generally moderate or low.

The second cluster "moderate knowledge consumers" towards *Spirulina* attributes and medical benefits had a 46.8% that was aware of *Spirulina* as a product but had never tried it and a 37.8% that used the product in occasional or regular basis. They were consumers who seemed to be interested into healthy living and were interested in making healthy eating choices. This is logical, since as consisted mainly of public sector

employees earning a good monthly individual income, by Greek standards, they were more likely to have the time and money to deal with these kinds of issues. Also, they are people with a high level of education, which can trigger an interest in making better and healthier food choices.

Several studies, covering different parts of the planet (from the USA to Japan and from Northern Ireland to Korea) have established a connection between the use of dietary supplements and being of an older age, being female versus being male, having a higher school education versus a high school one, having a higher income, being physically active versus having no physical activity, keeping a normal body weight versus being overweight or being into a healthy lifestyle, for example, non smokers, non alcohol drinkers etc., (Kim et al., 2010; Block et al., 2007; Touvier et al. 2006; Gunther et al., 2004; Ishihara et al., 2003; Hoggatt et al., 2002; Messerer et al., 2001; Radimer et al., 2000). The respondents with moderate knowledge are older, have a higher education and a better income compared to those with low knowledge. Interestingly enough, we observe that the sociodemographic factors responsible for the differences in the level of knowledge follow similar patterns with those factors that were investigated in the studies mentioned previously, as far as the level of use of dietary supplements is concerned, proving that awareness of the existence of a certain dietary supplement, and in the case of *Spirulina*, as well as knowledge of the beneficial role of such a product is bound to precede the use of it.

## LIMITATIONS AND RECOMMENDATIONS FOR FURTHER RESEARCH

The results of this study should be interpreted taking into account three unavoidable limitations. Despite the following limitations, this study demonstrates a meaningful approach that identifies consumer awareness of the *Spirulina* product and segments based on their knowledge of attributes and health benefits, an area that has not been studied up to now. The first problem relates to the sampling method. This research employed a pseudo-random sampling method, which was adequate for the purposes of this study. As such, the results cannot be considered representative of the general active population of the city of Thessaloniki, or for the whole of Greece in general.

This limits the generalisation of the results. Future studies involving a national based representative sample in terms of geography and demographics could provide generalisation. The second limitation is that there may be other features regarding the attributes and health benefits of *Spirulina*. This study was limited to the variables that were considered to be the most important based on empirical results in previous literature. More in depth

research with the use of additional variables would allow for a more detailed analysis and improve the validity of the results. This study was exploratory in nature and sheds light on segments based on consumers' knowledge regarding the attributes and medical benefits of *Spirulina*, but further in-depth research is required on consumers purchasing behaviour and attitudes towards the product.

Finally, our study did not succeed at including a wider range of demographic and socioeconomic factors, especially those that are related with lifestyle, such as the degree of physical activity, involvement with leisure sports, health status as conceived by the respondent, smoking cigarettes or tobacco, drinking alcohol, maintaining a normal body weight, regular exercise at gyms, eating a diet rich in fruit and vegetables and so on. A future study is therefore needed, that will take into account all these factors, aiming at explaining in detail the reasons behind the differences observed within a population as far as awareness and use of dietary supplements is concerned and thus offering a tool to the relevant industry in marketing such products.

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