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Sustainability of food industry wastes for the production of healthy food: the case study of olive pâté

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A mio padre…ovunque lui sia

ABSTRACT

Industry and agri-food products generate a large amount of waste. The management and disposal of this waste has a major impact on the community in terms of costs and environmental pollution, so much so that in recent years, companies operating in industrialized countries have paid ever-increasing attention to the assessment of environmental impact and production of quality products. The valorization of these waste materials, through various recovery technologies, can generate a wide range of organic compounds with high added value.

In particular, the use of biophenols (specific phyto-compounds with antioxidant activity), extracted from processing waste from the agri-food industry, have recently attracted great interest in the market as antioxidant products since they can be used in various industrial sectors. Particular interest is linked to their application in the market of products for human health both as nutraceutical products and as cosmetics.

The exploitation of these waste allows to obtain more benefits at the same time: reducing the environmental problem caused by the disposal of waste, reducing the need for natural resources thanks to the extension of the product life cycle and the increase of a new, more sustainable market.

In particular, the extraction of polyphenols from the vegetation waters of the oil industries for use in the food sector has involved some researchers who have experimented with their inclusion in the olive paté, further increasing the beneficial properties of the product.

CONTENTS

INTRODUCTION

The exponential growth of plant waste production from the agri-food industry is a critical global issue, considering their conservation, disposal, environmental impact and potential health risks. However, the exploitation of plant waste/by-products for the recovery of value-added compounds offers a new path for industrial growth and waste management. The research and development of new functional foods and health products from low-cost raw materials are of great importance in the nutraceutical, cosmetic, pharmaceutical and agro-industrial sectors. Furthermore, the optimization of waste treatment methods to reduce the use of biomass and environmental risks and to improve the recovery of value-added compounds represents an urgent and necessary technological innovation for the benefit of humanity. Furthermore, from an industrial point of view, the use of food waste for the recovery of nutraceuticals is economical not only in the production line but also in their disposal.

Today, the increase in consumer awareness of the food they buy and consume and health has led to an increase in the demand for biologically containing active compounds, ie antioxidants, which can help the body fight oxidative stress. As a result, the search for new unconventional sources of antioxidant sources has become a priority for the food and pharmaceutical industry. The processing of fruit and vegetable waste has proven to contain precious molecules (antioxidants, dietary fibres, proteins, etc.) that can be extracted, purified and valorized in value-added products.

Recent foods and technologies of the past have paid much attention to the extension of the commercial life of food and beverages and little attention to the possible contribution to the

global sustainability of a supply chain, but the extension of the shelf life can counteract food losses. and the impact of logistics distribution[1]. In particular, numerous studies on the health benefits of olive oil have stimulated research into the recovery of active compounds from pruning residues. In this regard, some studies have evaluated the addition of polyphenols extracted from olive leaf residues in olive pâté.

This allows the reuse of waste, the insertion of a new healthy product on the market and the antioxidant action of polyphenols allows to preserve the product, prolong its shelf life and thus achieve a positive effect on economic and environmental sustainability since it has the recovery of active compounds and the reduction of waste downstream of the supply chain.

Olive pâté is a product obtained from the crushed table olives and the addition of olive oil. The selection of the aforementioned product was made considering the importance of olives, oil and derivatives in the Puglia region. These products are traditionally grown in Mediterranean countries (Spain, Italy, Greece and Turkey, mainly) and, more recently, in America, Australia and the Middle East[2]. In the Mediterranean area, olive growing is fundamental for cultural heritage and the economy with significant social and environmental impacts. Furthermore, the selection of this product has been influenced by the beneficial effects on human health due to all the antioxidant properties of the phenolic compounds.

[1] Amani e Gadde, 2015

[2] IOC, 2016

CHAPTER 1
RESEARCH DESCRIPTION

1.1 Objective of the study

The objective of this study is to study the cost analysis, to know the behavior of consumers and their relative willingness to pay more for a product with a high health value (olive pâté with the addition of polyphenols extracted from the leaves of olive tree), investigating what could be an acceptable additional price that most consumers would be willing to pay for their purchase.

1.2 Description of the activities carried out

The research was carried out during the three years of doctorate: from 2015 to 2018.

To achieve the objectives the work was divided into 5 steps:

- Literature analysis,
- First survey: oil and consumer preferences,
- Second and third survey: consumption habits high-health foods and olive paste
- Interviews and surveys: cost and sale of olive paste
- Analysis of collected data

1.3 Analysis of literature

First of all, a literature analysis was carried out on the production of agri-food waste and related problems. The research subsequently focused on oil and vegetation waters, on the extraction of polyphenols and on their agro-industrial use, then focusing on the consumer's willingness to purchase functional foods.

1.4 First survey: oil and consumer preferences

A first survey was conducted on consumer behaviour concerning the consumption of oil, the basic element of olive pâté, and the willingness to pay more for an oil with certain connotations (healthy and sustainable attributes).

1.5 Second and third surveys: consumption habits of foods with a high health value and olive paste

Subsequently, two other questionnaires were elaborated and then put on the report

- consumption habits of products of high health value with the relative willingness to pay (WTA) and
- on the consumption of olive oil and olive pâté both simple and enriched with polyphenols with the relative willingness to pay for an innovative product with high health value (WTA).

1.6 Interviews and surveys: cost and sale of olive paste

At the same time, a market survey was conducted to find out:

- the average cost of olive pâté;
- the trend in olive oil sales in recent years.

1.7 Analysis of the collected data

The data collected in the surveys were correlated and a comparative analysis of the phenomena under study was made. Comparing the different results with samples of different sizes made the information more reliable and the inhomogeneous samples produced statistically more reliable results.

CHAPTER 2

LITERATURE ANALYSIS

2.1 The agri-food industry and the management of by-products

The agro-food industry and its products generate a high amount of waste, mostly non-hazardous, usually sent to recovery operations pursuant to art. 7 of Legislative Decree no.22/97. The production of European agro-food waste is estimated at around 250 million tons/year. In Italy most of these wastes are by-products of the cereal processing industry (11 million tons/year), grapevine (2.3 million tons/year) and olives (1.2 million tons/year)[3]. The management of these residues and by-products represents a serious problem both from an environmental point of view, because some wastes have a very negative impact on the environment[4], and from the point of view of industrial sustainability due to the high costs of proper management relating to collection and disposal. So finding a way of re-use seems to be important and a smart system for environmental, social and economic sustainability[5].

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[3] Grassi G., Bridwater A.V., Biomass for Energy and environmental, agricolture and industry in Europe - A strategy for the future. Commission of the European Communities 1990

[4] Athanasia M. Goula , Harris N. Lazarides (2015), Journal of Food Engineering, vol.167, parte A, 1-86; http://www.prosodol.gr/?q=it/node/36

[5] Raul Dominguez-Perles, Diego A. Moreno, Micaela Carvajal, Cristina Garcia-Viguera, (2011) Composition and antioxidant capacity of a novel beverage produced with green tea and minimally-processed byproducts of broccoli, Innovative Food Science and Emerging Technologies 12, 361–368; Nadia Mirabella, Valentina Castellani, Serenella Sala, (2014) Current options for the valorization of food manufacturing waste: a review, Journal of Cleaner Production 65, 28e41; Canan Ece Tamer and Ömer Utku Çopur, (2014) Development of Value-Added Products from Food Wastes Springer Science Business Media New York A. Malik et al. (eds.), Food Processing: Strategies for Quality Assessment, Food Engineering Series, DOI 10.1007/978- 1-4939-1378-7_18

Also the legislator with the Ministry of Environment Decree no. 246 of 13.10.2016 (supplemented by the explanatory circular of the Ministry for the Environment n. of by-products contributes to the dissociation of economic growth from the production of waste as it favours technological innovation for the reuse of production residues in the same or in a subsequent production cycle, limits the production of waste and reduces the consumption of virgin raw materials " .

In other words, the increasing use of by-products becomes desirable and a social, economic and environmental duty as:

1 - reduces the amount of waste and the problems deriving from its disposal;

2 - favours the production of additional economies;

3 - reduces the exploitation of virgin raw materials.

The guidelines, as well as the trend at a regional and national level, consider the by-products of agro-industrial transformation, in particular, the olive oil sector, as resources to be exploited both from the agronomic point of view but, increasingly through new technological applications, as resources for the production of energy from renewable sources. For example, the possibility of recovering core fractions is now a practice that is spreading very quickly, thanks to the important technological innovations and the continuous systems that allow efficient recovery. The olive stones, according to the most recent reference standards, are considered biomass fuel from plant material produced by the exclusively mechanical processing of agricultural products, without chemical additives. Their calorific value is higher than the common pellets

or wood chips (peanut = 6500 Kcal / kg, pellet pc = 4500 Kcal / kg, pc chip = 3500 Kcal / kg). As a fuel, in addition to having a higher thermal yield, it greatly reduces the production of smoke and ash, improving the efficiency of boilers, fireplaces, ovens, etc. Spanish researchers have also shown that olive kernels can be used as a building material[6].

This strange material is not only ecological but is also characterized by good thermal and acoustic insulation.

Spain, being the first olive oil producer in the world, generates a large amount of waste in this sector. An olive oil contains only 20% of oil, so around 37 500 tonnes of waste is generated in the season.

In order to find a use for these waste the "Group of construction technologies and the surrounding environment" of the Polytechnic University of Madrid has carried out tests using different types of olive pits (whole, shredded and calcined) to be used as a material to construction and possible replacement of expanded clay. Scientists have pointed out that this new application of olive oil production waste reduces the density of construction materials and improves their thermal and acoustic properties. This, combined with the fact that their production cycle has less energy demand, converts them into a more sustainable alternative for the production of light construction mortars.

But the exploitation of waste from olive oil production, through various recovery technologies, can also generate a wide range of organic compounds with high added value.

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[6] "Viability of using olive stones as lightweight aggregate in construction mortars. del Rio Merino, Mercedes" pubblicato sulla Revista de la Construcción – Journal of Construction) (http://www.greenreport.it/news/rifiuti-e-bonifiche/noccioli-olive-produrre-materiali-costruzione-piu-sostenibili/

2.2 Valorization of waste

Companies operating in industrialized countries have increasingly focused on assessing environmental impact and producing quality products.

In fact, in recent years, instead of disposing of waste or simply using it as compost or biomass, we are studying how to extract active substances[7]. So a total change of perspective that transforms waste into by-products to be enhanced giving life to a circular economy and the possibility of interaction and collaboration between agriculture, business and research, imposing the latter new productive and commercial strategies[8].

This is the case of the olive oil industry. Every year 10,000 tons of wastewater are generated[9] that require specific treatments to reduce environmental damage. However, the vegetation waters of the olive oil are rich in polyphenolic substances, the polyphenols, whose exceptional antioxidant properties[10] and the health benefits have been and still are a source of intense study and research[11]. The positive effect of polyphenols was also established by the European Food Safety Authority (EFSA). Therefore, the recovery of polyphenols from wastewater offers two opportunities: to obtain bioactive compounds and reduce their phytotoxicity to limit environmental damage[12]

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[7] Omar Santana-Me´ridas et al. (2012); Fabio Bazzarelli et al. (2016); Laura Vergania et al. (2016); Chandrasekar Chinnarasu et al. (2016);Scoma et al. (2011)

[8] Rosaria Ciriminna, Francesco Meneguzzo, Alexandra Fidalgo, Laura M. Ilharcoa, Mario Pagliaro (2016), Review Article, Extraction, benefits and valorization of olive polyphenols,Eur. J. Lipid Sci. Technol. 2016, 118, 503–511

[9] Ilyes Dammaka,b,1 et al. (2016)

[10] Wieland Peschel et al (2006)

[11] Ilyes Dammak et al. (2016)

[12] Athanasia M. Goula et al. (2015); http://progettoavg.it/tag/inquinamento/Acque di Vegetazione | Progetto Cluster Top Down – Sardegna Ricerche

2.3 Characteristics of olive oil

The olive tree is a plant known since antiquity. In the Mediterranean countries, the cultivation of olives and the relative production of olive oil is an important activity in the agricultural food sector and in the agricultural economy.

Its cultivation has always had a considerable economic and social importance in countries such as Spain, Italy or Greece, where most of the world olive production (about 98%)[13] is estimated at around 10 million tons. In Italy, about 2,500,000 tons of olives are used for the production of oil.

The current production of olive oil is spread from the Mediterranean basin to new producers such as Australia, the USA and the Latin American countries.

Olive oil is one of the key foods of the Mediterranean diet (a diet that UNESCO has recognized as "Intangible Heritage of Humanity") and should be considered the condiment par excellence of traditional dishes. It is a product obtained from the pressing of Olea Europea. Its use in the preparation of food offers the consumer undoubted nutritional, health and organoleptic benefits already included in antiquity, so much so that olive oil is traditionally considered a substance halfway between food and medicine[14]. In addition to being used as food, it was used for therapeutic properties, such as a laxative, hepatoprotective and also against gastric ulcer and for the preparation of soaps, balsams and perfumes in the cosmetic industry. The conspicuous and constant use of this food has prompted many scholars to

[13] Rossi L., Piccinini S., Soldano M., Labartino N., Recupero e valorizzazione energetica (biogas) e di materia (fertilizzanti e mangimi) degli scarti organici di origine agroindustriali: indagine quali-quantitativa. Atti di seminario Ecomondo 2006

[14] Perez-Jimenez et al., 2005

investigate to discern the tradition from the real validity for the well-being of man. The knowledge of the chemical composition of this product was fundamental to understand its biological potential as a nutrient and thus to define it as a nutraceutical substance.

2.4 Olive oil and its phenolic compounds

The beneficial properties of olive oil are mainly linked to its composition, given the high content of oleic acid (a monounsaturated fatty acid which in this oil accounts for 75% of total fatty acids) and the presence of antioxidants such as vitamin A, vitamin E, simple phenolic compounds (hydroxytyrosol, tyrosol) and complexes (oleuropein). The phenolic compounds of the olive tree were first observed at the beginning of the last century by an Italian chemist (Canzonieri, 1906); to date, modern analytical techniques make it possible to identify the different forms, identifying more than fifty.

The benefits of the diet containing olive oil have been clearly highlighted in recent years by extensive clinical studies conducted on both the Mediterranean and non-Mediterranean populations. The populations that consumed olive oil in abundance, in fact, showed a reduced incidence of cardiovascular diseases. According to a recent study published in the international scientific journal "Gastroenterology" carried out by some researchers of the Bari Polyclinic and funded by the Italian Association for Cancer Research (Airc) the oleic acid contained in the oil and also produced by our body creates a barrier that

blocks intestinal cell inflammation and helps to prevent and fight bowel tumors[15].

The olive drupe is a source of phenolic and polyphenolic compounds with various biological activities, including antioxidant and anti-inflammatory properties[16]. The content of phenolic compounds of virgin olive oil varies mainly based on the temperature and the time of kneading. Phenolic substances do not only affect the stability of virgin olive oil but also contribute to taste and aroma.

The kneading of the olive paste does not affect only the yield in oil, but above all on the composition and on the characteristics of the virgin olive oil produced. Previous research has shown that the conditions of kneading affect the taste of the oil produced as they determine variations in the concentration of polyphenols[17] and volatile constituents[18]. Phenolic substances influence the stability of virgin olive oil[19] and contribute to its taste giving rise to the characteristic bitterish taste that, depending on their concentration, can be a positive or negative factor in the organoleptic analysis.

Among the phenolic compounds present in olive oil, hydroxytyrosol (HT), is a polyphenol that has been found a powerful antioxidant due to its ability to neutralize free radicals of oxygen and nitrogen, to inhibit the platelet aggregation and

[15] https://www.airc.it/news/nellolio-extravergine-la-sostanza-che-contrasta-i-tumori-intestinali

[16] Vissers MN, et al. J. Clin. Nutr. 2004, 58: 955-965; Funes L. et al. Food Chemistry 2009, 117: 589-598; Speranza L. et al. Phytother Res. 2010, 24: 1398-404

[17] Servilli M. et al. J. Agric. Food. Chem. 2003, 51: 7980-7988

[18] Angerosa F et al. J. Agric. Food. Chem. 1998, 46: 2940-2944

[19] Nissiotis M & Tasioula-Margari M Food Chemistry, 2002, 77: 371-376

epithelial cell activation and to protect against DNA damage[20]. The HT has also reported anti-carcinogenic properties because they are confirmed in vitro during studies carried out on different cell lines[21].

In recent decades numerous beneficial effects of phenolic compounds deriving from Olea europaea L. have been described, such as anti-inflammatory, anti-cancer, anti-angiogenic, anti-atherogenic, anti-ageing properties and, to date, have not been highlighted adverse effects. Much attention has been paid to anti-ageing properties in the last decades[22], and hydroxytyrosol, which is found in good concentrations in olives, is the most studied compound due to the high antioxidant properties. The evidence of all these properties has led EFSA (European Food Safety Agency) to approve an important health claim for Olive Oils, which gives the possibility to include on the label the words "The polyphenols of olive contribute to the protection of blood lipids from oxidative stress".

2.5 Vegetation waters

Unfortunately, the oil represents just 15-20% of the oil paste, the rest consists of two by-products known as pomace and wastewater, better known as vegetation waters[23].

The processing of olives consists in the separation of the two liquid parts (water and oil) and a solid phase (sansa). Olive oil is

[20] Visioli F. et al. Med Res Rev 2002; 22:65-75; Owen RW et al. Eur J Cancer 2000;36: 1235-1247

[21] Owen RW et al. Eur J Cancer 2000;36: 1235-1247

[22] Giovannelli, L.Beneficial effects of olive oil phenols on the aging process: Experimental evidence and possible mechanism of action. Nutrition and Aging, 1, 207-223

[23] Caputo A. C., Scacchia F., Pelagagge M., *Disposal of by-products in olive oil industry: waste to Energy solution*, Applied Themal Engineering, 2003, 23, 197-214

extracted mechanically by pressing and a three-phase centrifugation system replaced today by a new continuous centrifugation system that uses a two-phase decanter.

The extraction process inevitably leads to the production of variable volumes of by-products (pomace oil, OS) and of crusher wastewater (vegetation waters = AV), and using the centrifuge method (about 100 liters of vegetation water per 100 kg of olives) or the traditional method (pressure) (about 40 liters per 100 kg of olives)[24]. Italy produces about 2 million tons of AV each year and about 1.7 million tons of OS. In the Puglia region alone, about 790,000 tons of AV and about 680,000 tons of OS are produced annually[25]. The OS consists of solid fractions of pits and olive pulp, while the AV are formed from the water contained in the olives, plus other residues of the management of the crusher.

2.6 Disposal of vegetation waters - the legislation

The disposal of olive vegetation waters has for years been one of the major environmental problems for the countries of the Mediterranean basin because they are considered for a long time among the potentially most polluting agents among the wastewater of the agri-food industry and therefore their spreading on agricultural land it was initially hindered[26].

The chemical composition of wastewater is very variable. It depends on the olive tree variety, fruit maturity, harvest time and processing method. The main features are high COD (60,000-

[24] Tarantino E.,et al. Atti della giornata di studio "Innovazione Tecnologica e Qualità dell'Olio Extravergine di Oliva" 2004, 41-55

[25] fonte: Agecontrol, media 2003-2005

[26] G. Celano, N. Silvestri, M. Quinto, F. D'Alessandro, A.M. Palese C. Xiloyannis; Acque di vegetazione, risorsa da gestire, researchgat https://www.researchgate.net/publication/236313797_Acque_di_vegetazione_risorsa_da_gestire

185,000 ml/mg -1) and BOD (14,000-75,000 ml/mg-1), low pH, high polyphenols and a substantial amount of plant nutrients (N, P, K, Ca, Mg, and Fe)[27]. The removal of vegetation waters is a significant problem for producers and millers, but also for the entire community, due to the potential risk of pollution (in particular for polyphenolic substances). Spreading of the vegetation waters in the fields must be carried out only with caution, after an adequate assessment of their toxicity. In Italy, the law (No. 574, 1996) provides that the maximum amount to be used in the fields is 80 m^3 ha-1 for the centrifugal method and 50 m^3ha-1 for the pressure method.

Several studies have been carried out on the application of the mill's wastewater (vegetation waters) and their effect on soil, crops and the environment. The results of the literature show that the controlled agronomic use of vegetation waters causes generally positive effects on soil fertility and yield of various crops, generating in many cases an improvement in fertility as physical, chemical and microbiological characteristics.

Specifically, the use of vegetation waters on olive crops, a practice widespread in many areas of our country[28], does not have any negative effect on the state of the vegetative plant physiological parameters (photosynthesis, transpiration, stomatal conductance, carbohydrates of chlorophyll in the leaves) or on the productive and qualitative characteristics of the extracted oil[29]. In many cases, positive effects have been noted of the use of vegetation waters on

[27] Pacifico R., 1989. Acque di vegetazione. Notiziario dell'Enea e di Renagri. Agricoltura e innovazione "Dossier: Acque di Vegetazione", Luglio-Settembre
[28] Raglione M., D'Ambrosio C.,. L' Informatore Agrario. 2001 3: 29-40
[29] Bonari E., Ceccarini L. L' Informatore Agrario. 2001 3: 121-146; Silvestri N., Bonari E.,. Quaderni I Georgofili – Firenze. I reflui oleari: da rifiuto a risorsa, 2003,13-35

production compared to the control sample[30], probably due to the fertilizing properties of the vegetation waters. The contribution of water and organic substances contained in the vegetation waters, in particular in the arid zone where these substances are generally lacking, improves the stability of the soil structure, due to the bonding effect of certain substances coming from the decomposition of the waste, such as polysaccharides.

The phenolic compounds present in vegetation waters contain a significant amount of valuable antioxidant phenols including hydroxytyrosol, tyrosol and verbascoside[31] which can be recovered for industrial applications as food additives and cosmetics. Many studies of a chemical nature[32] have indicated that some polyphenolic compounds present in vegetation waters perform a number of important functions, such as protection against UV radiation, antimicrobial activity against a wide range of bacteria, etc.

Therefore, more and more often, the waters of vegetation are considered not as a production waste but as an agricultural product to be exploited and then used in different sectors. They have already been used successfully in the production of water-based paints, in agriculture, inhibiting the growth of pathogens, and also in the cosmetics industry, producing cosmetics that protect the skin from free radicals.

Ultimately, the problems that still hinder the use of vegetation waters in agriculture are above all logistics, that is to say, the

[30] Proietti P.et al.,. L'Informatore Agrario 1988 15: 87-91

[31] Mantzavinos D., Kalogerakis N. Environ., Int. 2005 31: 289; Bertin L. et al. Chem. Eng. J. 2011 1287

[32] Visioli F., Caruso D., Galli C., Viappiani S., Galli G., Sala A., *Olive Oils Rich in Natural Catecholic Phenols Decrease* Biochemical and Biophysical Research Communications Isoprostane Excretion in Humans, 2000, 278, 797–799

nature of the connections with the organization of harvesting (long time needed) and distribution (seasonal nature of distribution)[33] .

(The legislation on agronomic use of vegetation waters No. 319 of 1976, known as the "Merli law"; law 11 November 1996, n. 574 "new rules on the agronomic use of olive waste and discharges from oil mills" (in which the maximum permitted levels for spreading have been established); Legislative Decree 3 April 2006, n. 152 "environmental regulations")

2.7 Methods of extraction of polyphenols

Until now, the extraction methods traditionally used to obtain polyphenolic compounds for the nutraceuticals market have been limited to hydrodistillation or the use of organic solvents. The latter method has several drawbacks, such as the use of large quantities of toxic, inflammable and expensive organic solvents, the presence of potentially harmful residues in the extract and the production of large quantities of residues with a high polluting effect. For these reasons, in recent years there has been an increasing interest among producers, chemists or chemical engineers in the development of so-called chemical processes with low environmental impact.

In 1991 Anastas and Warner introduced the green or sustainable chemical term to indicate compliance with at least one of 12 principles designed to reduce the use and production (also in the form of by-products) of substances harmful to the environment and to the man[34]. Ten years later, the principles of green or sustainable engineering proposed by Anastas and Zimmerman quickly[35] attracted the attention of scientists and consumers,

[33] Mastrorilli M., et al.. Agricoltura ricerca 2000,187: 105-112; Rinaldi M. et al. Field Crops Research 2003 84: 319-326
[34] Badami B. V. Resonance, 2008, 11: 1041-1048
[35] Anastas P., & Zimmerman J. B. Env. Scie. Technol., 2003 37: 94a-101a

arousing in the public a growing awareness of the need to develop safe and low environmental impact chemical processes[36]. These principles lead to an overall change in the current development of production processes: the polluting effect must be avoided from the beginning of the processes, without the need for reorganization measures after production. One of the possibilities supported in the 90s to reduce the environmental impact of chemical processes has been the replacement of unwanted solvents with safer solvents. As an alternative to the use of chlorinated, aromatic and volatile solvents, we have identified possible alternatives such as aqueous solutions, therefore supercritical and ionic liquids[37]. The main candidates for the role of solvents for low environmental impact projects are water and carbon dioxide (CO2) as they are compatible with the environment and it is possible to suitably vary their solvents by intervening on working parameters such as temperature, pressure and flow velocity[38].

2.8 Subcritical water extraction

Subcritical water extraction (SCWE) extraction is a low environmental impact technique that can be carried out at temperatures between 100 and 374° C. A noteworthy feature of SWE is its applicability to the extraction of polyphenolic compounds without these fractions suffer a substantial degradation.

Recently the results of SCWE on olive leaves have been reported for the recovery of antioxidant extracts rich in phenolic

[36] Anastas P. T. Tetrahedron 2010 66: 1026-1027
[37] Anastas P. T. Clean Solvents 2002 819: 1-9
[38] King, J. W. & Srinivas K. J. Sup. Fluids, 2009 47: 598-610

compounds[39]. Experimenting with different operating conditions, the best results were obtained by performing the extraction at a temperature of 200° C, which produced a higher yield of about 30% compared to ethanol extraction. The extracts produced with SCW also had a higher antioxidant activity.

Therefore the use of SCWE as a sustainable technology for the recovery of antioxidant fractions such as polyphenols, usable in the food, cosmetic and pharmaceutical sectors, could represent an effective tool for the exploitation of by-products or agricultural waste, as in the case of water of olive vegetation.

2.9 Extraction of polyphenols from the vegetation waters

Traditionally, liquid-liquid extraction was used to extract and recover phenolic substances from the vegetation water. This method uses a large number of organic solvents with a negative impact on both the environment and health. The advent of membrane filtration for the recovery of bioactive compounds, on the other hand, entails various advantages such as low energy consumption, the reuse of water obtained after filtration for irrigation purposes, the stabilization of the filtered elements, the absence of organic solvents. Other types of extraction to be included in "green technologies", do not include the use of organic solvents but specific temperature and pressure conditions that make water an excellent solvent. These technologies as

[39] Herrero M., et al., J. Chrom A., 2011 1218:7511-7520

"subcritical water extraction" allow recovering bioactive compounds mainly to solid matrices[40].

The extraction and therefore the recovery of the polyphenols from the vegetation waters of the oil mills[41] allows the achievement of a twofold objective: the recovery of water to be used for irrigation and the obtaining of a product with high added value features . The product that can be used as a raw material for the production of antioxidants to be used in the food industries. The studies made so far have highlighted the respective advantages of the extractions[42].

2.10 Functional foods

Numerous scientific research has highlighted the ability of certain foods and food components to bring significant health benefits as well as ensuring the ordinary needs of nutrients. The introduction into the diet of antioxidant compounds, such as polyphenols, is an effective way to combat the negative effects caused by the excess of reactive oxygen species (ROS) in the body. Oxidative stress, caused by ROS, is considered one of the main triggers of chronic diseases such as cancer, diabetes, cardiovascular or neurodegenerative disorders[43].

Particularly important is the possibility of preventing, by modifying eating habits, those pathologies that have spread in

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[40] Cardinali, A., Pati, S., Minervini, F., D'Antuono, I., Linsalata, V., & Lattanzio, V. (2012) Verbascoside, Isoverbascoside, and Their Derivatives Recovered from Olive Mill Wastewater as Possible Food Antioxidants, Journal of Agricultural and Food Chemistry 60, 1822–1829.

[41] Cardinali, A et al. (2008)

[42] I. D'Antuonoa, Vassiliki G. Kontogiannib, Kali Kotsioub, V. Linsalata, A. F. Logrieco , M. Tasioula-Margarib, A. Cardinali Food Research International 65 (2014) 301–310

[43] Maritim AC, Sanders RA, Watkins JB III. Diabetes, oxidative stress, and antioxidants: A review. Journal of Biochemical and Molecular Toxicology. 2003;17(1):24-38. DOI:10.1002/jbt.10058

epidemics over the last decades in the populations of countries in which there is economic well-being and, in this context, functional foods play a role fundamental in the continuous change in the demand for food goods.

In the big food industry, we start talking about functional foods from the early nineties with the terms "functional foods" "designer foods" or "nutraceuticals foods", used interchangeably to indicate all those products or food ingredients that offer particular physiological benefits, non-nutritive, for the improvement of health[44].

But between 1995 and 1999 a scientific definition of the term was created by a group of more than one hundred experts who worked on the FUFOSE project (Functional Food Science in Europe), a concerted action between the International Life Science Institute (ILSI) the European Commission.

In 1999, in the British Journal of Nutrition, the definition of "functional food" appears in the document "Scientific Concepts of functional foods in Europe, Consensus Document".

According to what is established in this document, a food can be defined functional if, beyond the nutritional properties, its ability to positively influence one or more physiological functions is scientifically proven to contribute to improve or preserve the health and well-being and / or reduce the risk of occurrence of diseases related to the diet. Functional foods are neither tablets, nor capsules, but foods that form part of a normal diet.

Therefore, both technologically advanced and improved foods, such as for example, can be considered "functional foods"

- products enriched with polyunsaturated fatty acids (w3 and w6),

[44] Hasler,1998

- added with biologically active substances (plant sterols),
- enriched with probiotic ferments (live cultures with beneficial properties),

both the more conventional ones, like

- green tea (for catechin content)[45],
- garlic (for hydro and lipo-soluble substances which give it anti cancerogenic and anti-cholesterol properties)
- olive oil (for tocopherols, carotenoids, substances of phenolic origin and about another 200 minor components that make it up)[46].

Some of the functional characteristics of these foods have been known since ancient times. It is well known that citrus fruits (especially lemon and mandarins) are rich in vitamin C, as are potassium bananas, carotenoid carrots, etc., and each of these elements is attributed the ability to prevent pathological states or improve the state of health.

2.11 Phenolic compounds in food

It is also possible to increase the beneficial properties of foods by adding phenolic compounds: the food industry is also moving towards the inclusion of polyphenols in food preparations just as a further enhancement of the food products themselves. In particular, biophenols are attracting the attention of companies that work in the nutraceutical sector, that is to say, those substances that have both nutritional and pharmaceutical character.

For the food and pharmaceutical industries, nutraceuticals, containing a high quantity of antioxidants, are proving a great

[45] Hrelia et al.,2009
[46] Cocchi, 2007

interest as food for the "protection of health". The oxidative reactions of human metabolism, in fact, generate a production of free radicals that must be counterbalanced by a series of defined antioxidant molecules. On this basis, in biological systems, biophenols, as they are associated with antioxidant activities, are one of the most studied examples. Precisely, the role of this type of antioxidants is emphasized in relation to human health and in particular the prevention and treatment of some forms of cancer[47].
In light of this research, and of the latest trends in the world market for food additives with protective actions on health, on the peculiar properties of the biofenols of agro-food waste, new products containing these molecules would meet the favor of consumers and industry in the production of so-called functional foods or traditional food products to which the molecules with the protective properties previously described are added.
Currently, there is no specific legislation on this category of food and its labelling in the European Union. Only a few foreign nations have precise legislation on the definition, labelling and marketing of functional foods. In Japan, for example, such foods are recognized and marketed under the abbreviation FOSHU (Food for Specific Health Use) and functional properties are proven by in vivo scientific surveys of the population.

2.12 Olive patè

Table olives (Olea europaea L.) are one of the most important traditional fermented vegetables in the western world[48] and, like

[47] Ioannis S. Arvanitoyannis Maria Van Houwelingen-Koukaliarglou Functional Foods: A Survey of Health Claims, *Pros and Cons, and Current Legislation* Critical Rieviews in Food Science and Nutrition, 2005, 45, 385-404

[48] Bleve et al., 2015

olive oil, one of the most characteristic components of the diet in the Mediterranean countries. World table olive production has steadily increased over the last 20 years and is mainly concentrated in Spain, Turkey, Egypt, Syria, Morocco, Italy and Greece. The International Olive Council (CIO, 2014) estimated that table olive production exceeded 2.4 million tonnes in the 2011/2012 season.

Table olives have been studied from a microbiological[49], chemical[50], and sensorial[51] point of view, but there are no studies in the literature on processed table olives, with the exception of a study conducted by Alvarenga et al. (2012).

According to the commercial standard applied (IOC, 2004), table olives are prepared from healthy olive fruits whose volume, shape, relationship between meat and stone, consistency and flavour make them particularly suitable for processing. In addition, they must be treated to remove the bitterness through natural fermentation or heat treatment, with or without the addition of preservatives.

Table olives have aroused increasing interest, due to their health benefits, which seem to be linked to a number of reasons: the high content of monounsaturated fatty acids, the important antioxidant capacity, the antimicrobial activity and the protection against mycotoxic effects due to minor constituents such as tocopherols and phenolic compounds[52].

[49] Pereira et al., 2008; Tassou et al., 2002; Hurtado et al., 2008; Arroyo-López et al., 2008; Panagoua et al., 2008; Campaniello et al., 2005

[50] Montano et al., 2003; Aponte et al., 2010; Romeo et al., 2010; Pasqualone et al., 2014

[51] Sabatini e Marsilio, 2008; Pérez et al., 2007

[52] Malheiro et al., 2011

The use of table olives is very varied: the fruits, appropriately processed, can be served as an appetizer or in addition to other foods such as salads, pasta, pizza, fish and meat. Even bread can be prepared by adding green or black olives to the dough[53]. As reported by IOC (2004), the consumption of table olives showed an increase mainly due to the marketing efforts by the producers essentially aimed at the introduction of new products, to meet the growing awareness of consumers about their health benefits. In this context, table olives characterized by defects in terms of size and / or shape, unsuitable to be marketed as such, could represent the basis for the preparation of new commercial products including olive-based pâté.

The term "pâté" means a processed product that has an important gastronomic tradition and good sensory properties with a coarse texture[54] in which the main ingredients are ground more or less finely and mixed with various ingredients.

Compared to other types of vegetable pâté - for example, pâté made from tomatoes, characterized by a complex formulation of the ingredients (the starting vegetable is usually associated with other types of ingredients, such as mushrooms, aubergines, peppers, oil, spices and herbs) - pâté made from olives almost always contain only table olives and olive oil.

2.13 Availability to pay

In recent decades, the evolution of eating habits for both demographic reasons and changes in lifestyle have led agriculture and the food market to many changes. Consumers are increasingly

[53] Sabatini et al., 2009; Lanza, 2012
[54] Ünlüsayin et al., 2007

looking for healthy, safe, tasty and environmentally friendly foods[55]. The agri-food system has therefore gone from a production orientation to an exclusive consumer orientation.

Therefore, companies must adapt to these requests and provide their consumers with new products with added value that can differentiate themselves from existing commodities.

To be able to satisfy the market, they must first estimate the demand from consumers for the new product and the related costs to be incurred.

The perception of quality and the choice made by a consumer towards a food product can be quantified by measuring his "willingness to pay" (WTP), or the maximum amount of money that he is willing to spend for the attributes of the product itself.

The introduction of modern food distribution systems and the subsequent disappearance of the direct link between producer and consumer have created in the latter the need to incorporate information by relying on different sources that create in him a sort of confidence in the purchased food product.

In this regard, Nelson (1970) distinguishes three main quality attributes in agro-food products: "search attributes", "experience quality" and "credence".

For "search attributes" the quality of the product is evaluated a priori and refers to the visual attributes of the product itself such as color, size and price;

for "experience quality" the quality can only be verified at the time of consumption and refers to the taste and consistency;

and the "credence" that can not be assessed at the time of purchase, but only through the activation of a trust mechanism between the

[55] Gao et al., 2010

producer and the consumer, for which the latter has only expectations regarding the product but can not have certainties .

These characteristics, today, seem to acquire an increasing and above all more and more decisive importance in determining the behaviour of the buyers.

The consumer can obtain information on these attributes, through the indications given on the label, the certifications by third parties or through the credibility of the private brand or the distributor. For food products, on the other hand, it can acquire information on categories such as production methods, local products, the origin of products as well as certification systems[56].

Both private companies, through well-defined marketing strategies and public organizations, have an interest that the consumer is able to understand this information. In fact, only if it is able to understand and grasp the added value that this product can bring, it will be available to pay a certain premium price.

2.14 Health claims

The growing information on the link between nutrition, health and disease prevention and the numerous institutional campaigns on the subject have led large groups of consumers to perceive and associate a greater added value to all those products that refer to health claims on the label or whose consumption calls to mind a positive effect on well-being. To these elements, the consumer increasingly associates an increase in usefulness for which he is willing to pay a premium price compared to goods that can not claim the same indications[57].

[56] Moser et al., 2011
[57] Lusk, Hudson, 2004

One of the ways to inform and enable consumers to evaluate the nutritional and health value of a product is through nutrition and health claims on the label.

The indications on health or "health claims" are guiding tools that allow the transfer of information from the producer to the consumer in relation to the positive health benefits that can be obtained from the consumption of the products themselves. They have the function of communicating specific messages on the advantages of the product and on the potential added value[58].

The salutistic-nutritional claims, as linked to human health, have been regulated by the decree of the European Union which provides in a very clear and precise way how and when to use salutistic-nutritional claims[59].

In particular, in the presentation and advertising of food products placed on the market, three types of claims can be used:

1. "nutritional claims": any indication that affirms, suggests or implies that a food has particular beneficial nutritional properties, referring to the contribution or the non-caloric intake; to the nutrients contained or not contained;
2. "health claims" means any indication that it affirms, suggests or implies the existence of a relationship between a category of food, a food or one of its components and health;
3. "Indications relating to the reduction of disease risk" means any health claim that states, suggests or implies that the consumption of a food category, a food or one of its components significantly reduces a risk factor for the development of a human disease.

The Regulation pursues two essential objectives:

[58] Lähteenmaki, 2013
[59] regolamento europeo 1924/2006

- the indications must not be false, ambiguous or misleading;
- the use of indications is allowed only if it is to be expected that the "average consumer who is normally informed and reasonably observant and circumspect and taking into account the social, cultural and linguistic factors" includes the beneficial effects conveyed by the indication correctly.

The first objective according to Grunert et al., (2011) can be reached with the scientific assessment of the claim by the responsible bodies such as the Efsa (European Food Safety Authority), while the second is linked to the way in which the claim is communicated to the consumer and above all what is understood. According to the authors, the term "average" referred to the consumer is not to be understood in a statistical sense, since the information contained in a given "health claim" can only be useful for a small part of the population.

Regulated nutrition and health claims can be a signal to correct asymmetric information in the food market to help consumers make better and more informed choices and avoid opportunistic behaviour on the part of producers, improving the efficiency of the market for the quality of food products[60]. However, failure to understand by the final purchaser could lead to a negative impact on market efficiency[61].

2.15 State of the art on consumer demand and willingness to pay for health food products

Factors affecting the perception of health claims and changing purchasing behaviour are socio-economic and demographic

[60] Beales et al. , Caswell & Mojduszka, 1996; Golan, Kuchler & Mitchell, 2001
[61] Nocella e Kennedy, 2012

factors such as age, income, education, nutritional knowledge, gender, etc. Generally, in families, especially women, they are oriented towards a healthy diet and are more careful and aware of the ingredients, the nutritional and health characteristics of the products. People with high income and / or good nutritional knowledge demand better quality and healthier foods. Elderly consumers are much more careful of young people to eat and behave in a healthy way, both for obvious physiological reasons[62] and for their lower health compared to young people[63]. Practicality and price are the determining factors for the purchase of young people, while the origin of the raw materials with which functional foods are produced is an important factor for middle-aged people[64].

These are elements that influence both the positive and negative aspects of the willingness to pay for a functional food[65].

Consumers are increasingly concerned about their health and their demands have changed considerably in recent decades[66]. The consumption of healthier food products has increased rapidly by entering strongly in global markets.

2.16 The market for functional foods

In particular functional foods are a relatively new concept that has emerged as a result of the recent growing attention and awareness on the influence of diet on general health[67]. They represent one of the most interesting areas of research and innovation in the food

[62] ISMEA, 2007; Worsley, Scott, 2000
[63] Klompenhouwer, van den Belt, 2003
[64] Krystallis et al., 2008
[65] Lusk, Hudson, 2004
[66] Giannetti, Testani, & recchia,2009; (Gracia, A., López, B., Virtué, S. 2011
[67] Poulsen, 1999

sector[68]. Their consumption, especially in the last decade and starting from some pioneering countries like Japan, has progressively spread throughout the world[69], favoured by the growing importance that certain values such as the healthiness of food, the correct lifestyle and a diet balanced[70] have taken over from consumers.

Another element that has increased the consumption of functional foods has been the growing concern of consumers for health and the perception that nutrition directly influences them[71].

Health-conscious consumers who lead a healthy and informed lifestyle on the nutrition-health relationship are willing to pay more for functional foods, even if there are exceptions. In fact, a study shows that those who lead unhealthy lifestyles are willing to pay more for healthy food products, perhaps in an attempt to offset their unhealthy habits[72]. Other studies identify the young age, the knowledge of functional products and a healthy lifestyle as extremely important components in determining a higher willingness to pay[73]. A greater awareness of the quality of functional foods, the identification of the same with particular lifestyles and the pursuit of a healthy life, put in the background the aspects related to the price and the availability of income of consumers. In particular, several other surveys have shown that families, especially those with children, pay attention to the quality and healthiness of food products before the price[74].

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[68] Doyon & Labrecque, 2008; Jones & Jew, 2007; Schaafsma & Kok, 2005; Sirò, Kapolna, Kapolna, & Lugasi, 2008
[69] Martirosyan e Singh, 2015
[70] Hardy, 2000
[71] Klister-Boludaa, I. Vidal-Capillab,c, 2017
[72] Segovia, M.S., 2016
[73] De Francesco, Galvan, 2005; Bonanno, 2009, Del Giudice et al. 2009
[74] ACNielsen, 2006

There is a group of consumers who are interested in buying functional foods because they recognize health properties such as, for example, the prevention of certain diseases or curative effects, which are not present in conventional foods[75].

Several studies on this topic have shown that consumers who attach great importance to the health aspects of food are more willing to consume functional foods[76], even at the expense of other characteristics of food, such as the pleasant taste[77]. However, in other studies[78], it has been observed that some consumer attitudes, such as the lack of confidence in manufacturing companies, can be a cause of aversion to functional foods and negatively affect their consumption. To reduce these effects, an important role can be played by an adequate communication of the intrinsic properties of functional foods such as healthiness and contribution to disease prevention[79].

In general, it is possible to state that there is a positive perception of consumers towards functional foods[80]. However, the consumption of these foods does not seem to depend solely on their health characteristics and the prevention of diseases but also on other factors, such as the taste and origin of the raw materials with which they are produced[81], which are favouring entry functional foods in the daily eating habits of consumers, with important consequences for the food industry[82]. As also stated in another study[83], consumers who are looking for innovative

[75] Annunziata e Vecchio, 2011
[76] Henson et al., 2008; Moro et al., 2015
[77] Verbeke, 2006
[78] Siegrist et al., 2015; Stratton et al., 2015
[79] Ares et al., 2008; Tudoran et al., 2009
[80] Bonanno, 2013
[81] Coxa et al., 2004
[82] Falguera et al., 2012; Annunziata e Pascale, 2009; Thornsbury e Martinez, 2012
[83] Rungsaran Wongprawmas et al., 2015

products not influenced by the opinions of others in the purchase decision are willing to buy functional foods and that WTP does not depend exclusively on functional properties but also on other characteristics as appearance and taste of the snack taken into consideration for the survey.

Moreover, the characteristics of packaging such as colour or the presence of images can play an important role in consumer purchase intentions[84].

2.17 Labelling

Another aspect to consider is labelling. A study by Hwang on the different types of fibre labels examined the impacts of different types of fibre labels (that is, a regular label, labelled in fibre, labelled in fibre with a health claim) on consumer perceptions, purchase intentions and willingness to pay. The results reveal that fibre labelling with a health claim has made consumers willing to pay more.

The same in another American study[85]. By using an experimental auction and eye-tracking technology to detect the relationship between consumers' understanding of nutritional information and their willingness to pay for food, it shows that nutrition information on consumers has some effect on the purchase decision. Buyers are willing to pay less for fat and mineral information, but more for information on the ingredients, proteins, sodium and carbohydrates in the salad mix.

The 2015 global Nielsen health and well-being survey conducted on over 30,000 individuals online suggests that the consumer's

[84] Ares et al., 2010
[85] Ran, T., et al, 2017

mindset about healthy foods has changed and that they are ready to pay more for products that claim to increase health and weight loss.

• About 88% of respondents are willing to pay more for healthier foods.

• All demographics, from Generation Z to Baby Boomers, say they would pay more for healthy foods, including those that are GMO-free, do not have artificial colourings/flavours and are all considered natural[86].

[86]https://www.nielsen.com/content/dam/nielsenglobal/eu/nielseninsights/pdfs/Nielsen%20Global%20Health%20and%20Wellness%20Report%20-%20January%202015.pdf

CHAPTER 3

FIRST SURVEY: OIL AND CONSUMER PREFERENCES

To achieve the objective of the study, that is to assess the behavior of consumers and the willingness to pay more for a new healthy and sustainable product (olive pâté with the addition of polyphenols extracted from the olive leaves), a first questionnaire on extra-virgin olive oil (EVOO), a well-known product and fundamental ingredient of olive pâté.

The questionnaire had a dual purpose:

- to analyze consumer preferences for the EVOO product and understand which attributes influence consumer choices, e
- to evaluate how the standard and healthy characteristics, such as the presence of natural oil antioxidants (polyphenols), affect consumer preferences.

3.1 Materials and methods

A pilot test was conducted with a focus group to identify the attributes that characterize the EVOO profiles (production system, origin of production, packaging, brand, indications of PDO/PGI, high level of antioxidants) used in the experiments. In this phase a questionnaire was carried out and submitted to a focus group of 15 experts. After that the questionnaire was distributed online through the "Survey Analytics" software[87], an ideal tool for university research, market and sector analysis.

The questionnaire was also administered through the social network Facebook, posting the link to the questionnaire on the

[87] https://www.surveyanalytics.com

home page and asking friends to fill it out and, in turn, to share it in such a way as to widen the survey as much as possible. An additional means of dissemination was the publication on a blog specialized in the oil sector[88]. Thanks to the publication of the questionnaire in the specialized blog it was possible to obtain important information. The purpose of differentiating the dissemination of the survey was to make the distribution as heterogeneous as possible in terms of age and knowledge in the oleic sector.

The data collected were analyzed using the STATA 14 statistical software. The survey was attended by 450 respondents, selected randomly among Italian consumers. During the data screening there were 157 cases that did not complete the questionnaire, so they were removed, reaching a final sample of 293 respondents.

The average age of the sample is 33.3 years; of these 297 have indicated the region of residence and it has emerged that 78.8% is resident in Puglia; 320 respondents indicated their gender within the questionnaire; among these, 51.7% are male and 48.3% are female.

The conjoint analysis was used to identify which attributes most influence consumer choices and which standard and health features, such as the presence of natural oil antioxidants (polyphenols), influence consumer preferences. You were asked to score EVOO attributes (nutraceutical and environmental attributes) that influence purchasing behavior, using a Likert scale format from 1 to 7 where 1 indicates zero satisfaction and 7 a complete satisfaction. In addition, respondents were asked the

[88] http://primolio.blogspot.it

price they would be willing to pay from 6 to 12 € / bottle (750 ml) for an EVOO with selected attributes.

Table 1 - The importance of healthy properties information on the EVOO label (no currently regulated).

Strongly disagree	5	1,59 %
Disagree	7	2,22 %
Disagree somewhat	5	1,59 %
Undecided	13	4,13 %
Agree somewhat	44	13,97 %
Agree	116	36,83 %
Strongly agree	125	39,68 %
TOTAL	**315**	
Mean	5,96	
Standard Deviation	1,26	
Variance	1,60	

Table 2 - The influence of the label's information, enabling product's environmental impact, on the purchasing choices

Less than 10%	16	5,18 %
From 10 to 30%	58	18,77 %
From 30 to 60%	89	28,80 %
From 60 to 80%	99	32,04 %
More than 80%	47	15,21 %
TOTAL	**309**	
Mean	3,30	
Standard Deviation	1,10	
Variance	1,22	

Table 3 - Consumers' preferences regarding EVOO purchasing

a) PRICE		
1	29	9,21 %
2	25	7,94 %
3	39	12,38 %
4	57	18,10 %
5	75	23,81 %
6	45	14,29 %
7	45	14,29 %
TOTAL	**315**	
Mean	4,39	
Standard Deviation	1,79	
Variance	3,22	
b) BRAND		
1	37	11,78 %
2	23	7,32 %
3	41	13,06 %
4	54	17,20 %
5	62	19,75 %
6	51	16,24 %
7	46	14,65 %
TOTAL	**314**	
Mean	4,33	
Standard Deviation	1,88	
Variance	3,55	

c) COUNTRY OF ORIGIN			
1	3	0,95 %	
2	3	0,95 %	
3	5	1,58 %	
4	10	3,16 %	
5	28	8,86 %	
6	56	17,72 %	
7	211	66,77 %	
TOTAL	**316**		
Mean	6,38		
Standard Deviation	1,13		
Variance	1,27		
d) LABEL INFORMATION			

1	5	1,59 %
2	3	0,96 %
3	23	7,32 %
4	34	10,83 %
5	53	16,88 %
6	61	19,43 %
7	135	42,99 %
TOTAL	**314**	
Mean	5,71	
Standard Deviation	1,47	
Variance	2,16	
e) PACKAGING		
1	26	8,41 %
2	25	8,09 %
3	54	17,48 %
4	56	18,12 %
5	64	20,71 %
6	44	14,24 %
7	40	12,94 %
TOTAL	**309**	
Mean	4,29	
Standard Deviation	1,77	
Variance	3,12	
f) HIGH CONTENT OF ANTIOXIDANTS (POLYPHENOLS)		
1	3	0,97 %
2	8	2,60 %
3	28	9,09 %
4	48	15,58 %
5	57	18,51 %
6	61	19,81 %
7	103	33,44 %
TOTAL	**308**	
Mean	5,41	
Standard Deviation	1,51	
Variance	2,28	

Table 4- Consumers' willingness to pay (€) for 750 ml of EVOO considering the profile selected by respondents

1) dark glass bottles, brand known at local level, organic, Italy		
< 6,50 €	55	20,07 %
6,50 € - 7,50 €	76	27,74 %
7,50 € - 8,50 €	60	21,90 %
8,50 € - 9,50 €	33	12,04 %
9,50 € - 10,50 €	25	9,12 %
10,50 € - 11,50 €	13	4,74 %
>11,50 €	12	4,38 %
TOTAL	**274**	
Mean	2,94	
Standard Deviation	1,64	
Variance	2,70	
2) dark glass bottles, brand known at local level, organic, Italy, high level of antioxidants		
< 6,50 €	38	13,92 %
6,50 € - 7,50 €	63	23,08 %
7,50 € - 8,50 €	63	23,08 %
8,50 € - 9,50 €	52	19,05 %
9,50 € - 10,50 €	25	9,16 %
10,50 € - 11,50 €	17	6,23 %
>11,50 €	15	5,49 %
TOTAL	**273**	
Mean	3,27	
Standard Deviation	1,65	
Variance	2,72	
3) dark glass, brand known at local level, PDO/PGI indication, Italy		
< 6,50 €	43	16,10 %
6,50 € - 7,50 €	69	25,84 %
7,50 € - 8,50 €	65	24,34 %
8,50 € - 9,50 €	47	17,60 %
9,50 € - 10,50 €	21	7,87 %
10,50 € - 11,50 €	13	4,87 %
>11,50 €	9	3,37 %
TOTAL	**267**	
Mean	3,03	
Standard Deviation	1,54	
Variance	2,38	
4) dark glass, brand known at local level, PDO/PGI indication, high level of antioxidants		

< 6,50 €	32	11,9 %
6,50 € - 7,50 €	59	21,93 %
7,50 € - 8,50 €	68	25,28 %
8,50 € - 9,50 €	53	19,70 %
9,50 € - 10,50 €	25	9,29 %
10,50 € - 11,50 €	19	7,06 %
>11,50 €	13	4,83 %
TOTAL	**269**	
Mean	3,33	
Standard Deviation	1,60	
Variance	2,57	
5) dark glass, brand known at national level, PDO/PGI indication		
< 6,50 €	44	16,67 %
6,50 € - 7,50 €	75	28,41 %
7,50 € - 8,50 €	61	23,11 %
8,50 € - 9,50 €	40	15,15 %
9,50 € - 10,50 €	24	9,09 %
10,50 € - 11,50 €	16	6,06 %
>11,50 €	4	1,52 %
TOTAL	**264**	
Mean	2,96	
Standard Deviation	1,50	
Variance	2,26	
6) dark glass, brand known at national level, PDO/PGI indication, high level of antioxidants		
< 6,50 €	35	13,06
6,50 € - 7,50 €	61	22,76
7,50 € - 8,50 €	63	23,51
8,50 € - 9,50 €	57	21,27
9,50 € - 10,50 €	28	10,45
10,50 € - 11,50 €	12	4,48
>11,50 €	12	4,48
TOTAL	**268**	
Mean	3,25	
Standard Deviation	1,56	
Variance	2,45	
7) dark glass, brand known at national level, conventional, Italy		
< 6,50 €	90	33,46 %
6,50 € - 7,50 €	68	25,28 %
7,50 € - 8,50 €	47	17,47 %
8,50 € - 9,50 €	36	13,38 %
9,50 € - 10,50 €	16	5,95 %
10,50 € - 11,50 €	7	2,60 %

>11,50 €	5	1,86 %
TOTAL	**269**	
Mean	2,48	
Standard Deviation	1,50	
Variance	2,24	
8) dark glass, brand known at national level, conventional, Italy, high level of antioxidants		
< 6,50 €	62	22,96 %
6,50 € - 7,50 €	75	27,78 %
7,50 € - 8,50 €	62	22,96 %
8,50 € - 9,50 €	40	14,81 %
9,50 € - 10,50 €	12	4,44 %
10,50 € - 11,50 €	10	3,70 %
>11,50 €	9	3,33 %
TOTAL	**270**	
Mean	2,74	
Standard Deviation	1,53	
Variance	2,33	

3.2 First survey results

The results show that consumers' attention to the healthy and positive properties of EVOO is increasing. This is confirmed by their importance to specify the presence of the above properties on the label (39.68% of the sample), as shown in Table 1.

According to 32.04% of respondents, the presence of information on the environmental impact on the label would have a strong influence (from 60 to 80%) on the purchase choices (table 2). Considering the price attribute, the majority of respondents, 28.10%, give a relative importance to the price; 9.21% do not give importance and 14.29% gives a high importance (table 3).

19.75% of respondents are moderately influenced by the brand in the purchase of EVOO, 11.78% is not affected, 14.65% is strongly influenced (table 3).

Regarding the country of origin, 66.77% of respondents give a strong attention to this attribute.

42.99% is strongly influenced by information on the label (table 3).

20.71% is influenced by packaging, 12.94% is strongly influenced while 8.41% does not give any importance (table 3).

33.44% is strongly influenced by the presence of antioxidants (polyphenols), instead 19.81% gives a high importance and 18.51% a moderate importance (table 3).

Consumers are willing to pay a higher price for a product with a higher level of antioxidants (polyphenols) (Table 4):

In option 1, 27.74% of consumers are willing to pay a price between 6.50 and 7.50 euros;

23.08% of respondents are willing to pay a price ranging from € 7.50 to € 8.50 for option 2; 25.84% are willing to pay from € 6.50 to € 7.50 for option 3; in option 4, 25.28% of respondents are willing to pay a price between € 7.50 and € 8.50; 28.41% are willing to pay from € 6.50 to € 7.50 for option 5; 23.51% of the respondents would have paid a price between 7.50 and 8.50 euros for an EVOO with characteristics described in option 6; 33.46% are willing to pay less than € 6.50 for a product with the characteristics of option 7; in option 8 27.78% is willing to pay a sum of between 6.50 and 7.50 euros.

3.3 First survey conclusions

It has been noted that the most appreciated price ranges for those interviewed are those between € 6.50 and € 8.50; there are not many differences between BIO, PDO, PGI products and conventional products because the interviewees always want to

pay the lowest market price even if they are willing to pay an extra euro for products with a high antioxidant content, and as already highlighted in previous studies, also the geographical origin and the local brand determine a premium price. Organic certification seems to affect the willingness of consumers to pay.

So we can deduce that the nutraceutical attributes positively influence the preferences of consumers that determine a premium price of the product (as evidenced by the willingness of consumers to pay for a product with these connotations). As a result, healthy and sustainable attributes could become product differentiation for the marketing strategy to penetrate the segments of new markets.

CHAPTER 4

MARKET SURVEY ON THE COST AND SALE OF OLIVE PATE'

This phase was represented by an exploratory survey aimed at understanding the current olive oil market offer. Specifically, we wanted to know:

- the average cost of olive paté;
- the trend in olive oil sales in recent years.

4.1 Materials and methods

In order to identify the current average price of olive paste two types of retailers have been considered: supermarkets and local shops.

The survey was conducted in the city of Foggia selecting the following points of sale: "Conad", "Coop", "Dok" and "Convì", "Non solo carni", "Carni e affini".

4.2 Market survey results

The assortment of olive paté was analyzed for each exercise. In supermarkets it is more extensive and, above all, the most economical products are preferred; in neighborhood shops, instead, the products are more expensive.

The composition of the ingredients is, in general, the same, changes the amount contained in the packs that are around 180 grams. The price changes both with respect to the content and the type of brand. The price per jar goes from a minimum of € 1.26 (130 gr) to a maximum of € 3.90 (185gr). The used jars are all in transparent glass.

The quality of olives most used by almost all brands is that of black olives. Among the companies examined only two (Saper di Sapori and Terre e gusti) they also use green olives. The basic composition of the ingredients of the product is almost always the same (olive paste, oil, salt, acidity regulator) but the quality changes. In almost all packages an acidifier is used which can be lactic or citric. If not used, the price of the product is higher.

The places of production extend in all parts of Italy, from north to south.

The average cost of a jar is € 1.88 in supermarkets (Tab.1) and € 3.40 in the neighborhood shops (Tab.2). The quantity of product contained in the containers varies from brand to brand.

To analyze the general trend of olive paté sales, both supermarket managers and owners of neighborhood shops were interviewed.

From the replies received, it has been found that in the last three years the demand for olive paste has increased considerably, in fact, we have moved from an almost non-existent sale, due to the non-knowledge of the product by the final consumer, to a requested product.

SUPERMARKET

I Tesori
€ 2,75

Coop
€ 1,26

Biffi
€ 1,91

Delidor
€ 1,49

NEIGHBORHOOD SHOPS

Le conserve della nonna
€ 3,80

L'orto di Liguria
€ 3,90

Table 5 SUPERMARKET

Super market	Product name	Ingredient	Quantity	Price	Type of container	Production place
Conad	I tesori Patè di olive	90% pitted taggiasche olives; -100% Italian extra virgin olive oil 10%	180 gr	€ 2,75	Glass jar	Chiusavecchia (Imperia)
Coop Marchio Coop	Patè di olive nere	86% black olives, extra virgin olive oil, salt, acidifier: lactic acid	130 gr	€ 1,26	Glass jar	Sant'Ansano Vinci (Firenze)
Coop Marchio Biffi	Patè di olive nere	85% black olives, ferrous gluconate, olive oil, salt, Origan, black pepper, acidity regulator: lactic acid	140 gr	€ 1,91	Glass jar	San Rocco al porto (Lodi)

Convì Marchio Delidor	Patè di olive nere a regola d'arte	83% black olives, olive oil, salt, acidity regulator: citric acid	190 gr	€ 1,49	Glass jar	Sommacampagna (Verona)
Dok Marchio Saper di sapori	Pate of black olives Pate Of Green Olives	82% black olive paste, extra virgin olive oil 14%, salt, acidity correctors: citric acid, lactic acid	180 gr	€ 1,99	Glass jar	Reino (Benevento)
Super market				**Average price € 1,88**		

Table 6 NEIGHBORHOOD SHOPS

Neighborhood shops	Product name	Ingredient	Quantity	Price	Type of container	Production place
"Non solo carni" Marchio Le conserve della nonna	Pate of black olives	Black olive paste (black olives, olive oil, salt) 98%, garlic, chili pepper, sugar, herbs	190 gr	€ 3,80	Glass jar	Ravarino (Modena)
"Non solo carni" Marchio Terre e gusti	Pate of black olives Pate of green olives	Italian black olives 86%, 10% olive oil, salt, acidity regulator: citric acid	190 gr	€ 2,70	Glass jar	San Severo (Foggia)
"Non solo carni" Marchio Terre dei Gigli	Pate of black olives	96% black olives, Extra virgin olive oil, salt, acidity regulator: lactic acid	180 gr	€ 3,20	Glass jar	Diano D'Alba (Cuneo)
"Carni e affini"	Pate of olives	Pitted olives 89%,	185 gr	€ 3,90	Glass jar	Bastia di Albenga (Savona)

Marchio L'orto di Liguria		salt, 4% extra virgin olive oil, glucose syrup				
Neighborhood shops				**average price** **€3,40**		

CHAPTER 5

SECOND AND THIRD SURVEY: CONSUMPTION HABITS OF HIGH FOOD AND HEALTHY OLIVE PATE' FOOD

In this phase, two statistical surveys were carried out, which provided for the online administration of structured questionnaires whose results were then put in relation. The topics of the questionnaires were:

- consumer behavior on products with high health value and the relative willingness to pay (WTA) end

- consumption of olive oil and olive patè, the latter being simple and enriched with polyphenols, with the relative willingness to pay for an innovative product with high health value (WTA).

5.1 Materials and methods

The questionnaires were created with the Google Forms software, which allows the creation of questionnaires or surveys to be published in blogs or personal sites or simply sent by email. The same then was sent through WhatsApp, social networks (Facebook) and email.

In the first questionnaire, 500 Italian and adult consumers selected randomly participated in the survey, while in the second, 315.

Before starting the actual survey, an online pre-test was carried out on a sample of 15 people to check whether the specially prepared questionnaires went well.

For the answers, a Likert scale from 1 to 7 was used, where 1 indicates a zero satisfaction and 7 a complete one. The collected

data were put in relation and a comparative analysis of the phenomena studied was made.

5.2 Second and third results

5.2.1 First questionnaire results (in blue figures)

The gender distribution between men and women is substantially balanced (Fig.1), such as age, even if the age group 46-55 is prevalent. (Fig. 2). Most respondents have a second level degree (Master's Degree) (Fig. 3) and 85% an income of fewer than 1000 euros.

Almost all the respondents consider very important the presence of detailed information on the label (eg: list of ingredients, energy value, nutritional content, etc.) (Fig.7), 41.4% consider the choice of a food product extremely influenced by this information, while 22% very influenced. 41.3% consider the presence of indications on the label to be beneficial for health and 23.4% very important. Only 0.6% do not agree (Fig. 8).

41.4% consider the presence of quality certifications (eg PDO and PGI) extremely important and 23.4% very important. (Fig. 9).

34% are extremely interested in receiving information on high-quality foods, 20.4% are very interested (fig 5 labels on health benefits).

39.9% are not used to consume them for the highest cost, 38% because they believe that information on these foods is unclear and sometimes conflicting, 26% because it is not informed enough while 12.1% because it poses little attention to health aspects. (Fig 12).

As the current legislation does not provide for a labeling regulation on nutraceuticals, we asked if they agreed to insert it.

Most believe it is necessary. In particular, 44% believe that it would be extremely important, 26.80% very important.

24.4% of respondents have very modified their diet by adopting a healthier model based on the consumption of a variety of mainly vegetarian and whole foods with a low intake of animal fats and preference of vegetable fats. 23.8% instead modified it very much. Only 7% consider this change to be unimportant.

41.2% usually consume EVOO and almost all respondents believe that it produces beneficial effects on health. In particular, 56.8% consider it an antioxidant, 34% believe it protects against the risk of cardiovascular disease, 6.4% from oncological diseases and only 2.4% are convinced that it has no beneficial effect on health. As far as the olive paste is concerned, most respondents believe it has beneficial health effects. Specifically, 43.2% believe it is an antioxidant and therefore prevents cell ageing; 20.4% presume protects from the risk of cardiovascular disease and 4.2% from oncological diseases (fig 11). 18% eat olive paté several times a year, and 19.2% once a year.

When asked respondents how much they would have been willing to pay more for the purchase of a jar of olive paste characterized by a higher content of polyphenols, 27.2% said they would be willing to pay up to 1 euro more than the purchase price, 10% up to 0.25 euro, 20% up to 0.50 euro, 17% up to 1.50 euro, 7% up to 2.0 euro and the 7.4% up to 3 euros (Fig.10), so the majority of consumers, 88.60% are willing to pay more.

5.2.2 Results according to the questionnaire (in orange in the figures)

Women are much more represented than men with a percentage that is three times that of men (Fig. 1).
There is a clear prevalence of two age classes that are 26-35 and the over 55 (Fig. 2). Most respondents have a diploma (Higher diploma) (Fig. 3) and 85% an income of more than 1000 euros (Fig. 4).
33.10% consider extremely important the presence of detailed information on the label, 30.30% very important and 25.90% quite important (Fig. 7).
37% of respondents believe it is extremely important and 30.40% very important the presence of indications on the label on the beneficial properties for health (Fig. 8).
When asked how healthy his eating habits were, 45.2% of respondents replied that he thinks it is good, 28.6% very good and 16.6% mediocre.
33.4% declare that they sometimes read the nutritional label of a product before deciding whether to buy it or not, 32.2% most of the time. Only 17.6%, on the other hand, always read it.
For 51.37% of respondents, it is extremely important to know more about foods that have health benefits, for 34.48% it is very important. For 45.51% it is extremely important to eat with high-quality foods and for 38.62% very important.
For 56.20% it is extremely important that older people insert high-quality foods into their diet, for a very important 31.37%. 47.9% when buying a food product takes into account the health aspects of the food, the salt content, fat and calories, 26.9% the price and special offers, 24.9% the quality of the product and the brand. According to 34.1%, the choice of a food product is greatly

influenced by detailed information on the label such as the list of ingredients, energy value, nutritional content, etc., 25.9% highly influenced. The presence of indications on the beneficial properties for health (health claims) is very important for 38% of respondents.

36.4% consider the presence of quality certifications (such as the PDO and PGI brands, specific brands, etc.) extremely important and 29.10% very important (Fig 9).

For 36.6% it is very important the presence of a label with the environmental impact index of the product on the territory, while for 22.4% extremely important.

52.2% of those who are not used to consuming high-quality foods do so for the highest cost of food, 39.4% for information on these unclear and sometimes conflicting foods, while 22.3 % because it is not informed enough.

It was then asked how much the respondent would have been willing to pay more for a food product that would have beneficial effects on health. 28.96% would be willing to pay 50% more than the purchase price, 27.24% 20% more, and 22.06% 70% more

CHAPTER 6

COMPARED EMPIRICAL ANALYSIS OF SAMPLES

The first observation that comes from comparing the results of the two questionnaires is that both samples have completely different distributions only on two characters: sex and income. The second sample (orange) is composed of a higher number of women and the income is higher than the first. (Fig 4, Fig 1)

In both samples, the majority of respondents are female (Fig.1) and have a per capita income that ranges between 1001 and 2000 euros (Fig 4). The stated age is over 46 years (Fig. 2) and the level of education is homogeneous as 93% of the answers are in the three middle classes in both samples, with a minimum level of education that is diploma (Fig. 3).

Almost all the respondents consider themselves very interested in foods with a high health value (Fig. 6) and are interested in receiving information about it (fig 5). Furthermore, he believes that the choice of a food product is greatly influenced by the presence of detailed information on the label regarding the specific characteristics of the products (such as ingredients list, energy value, nutritional content, etc.), (Fig 7) and the presence of information on labels on health benefits is extremely important (Fig. 8) as the presence of labels for quality certifications (PDO and PGI) (Fig. 9) and an indication of beneficial properties on health (Fig. 8). Consumer considers important to eat high-quality foods (Fig. 6) and for this reason, it would be appropriate for all ages to include them in their diet and consumer convinced that these products bring benefits to health, proving to know what beneficial consequences lead to recruitment of the same. In this

regard, most states that they have changed their diet in favour of a healthier one.

The few who do not use high-quality products do so for the higher cost or because information is not clear or discordant (Fig.12). Respondents are sensitive to the environmental impact index stating that it should be indicated on the label as well as on the nutraceutical properties. As for the willingness to pay consumers are willing to pay a higher price for a product with a higher level of antioxidants (polyphenols) as already demonstrated in the previous survey referred to olive oil (tab 4).

An interesting fact to notice is that in the first part of the questionnaire asking about health food in general, respondents are all in favor of consuming foods with high health value and want to eat healthily, then when you go down in detail asking how much they would be willing to spending more for a product more enriched with polyphenols they do not all agree. Most respondents state that they use olive paste and 43.2% consider it to be a natural antioxidant (Fig. 11). 27.2% would be willing to pay one euro more than the purchase price for high-quality foods in general, in particular for olive paste the majority of consumers, 88.60% is willing to pay extra for your purchase (Fig. 10).

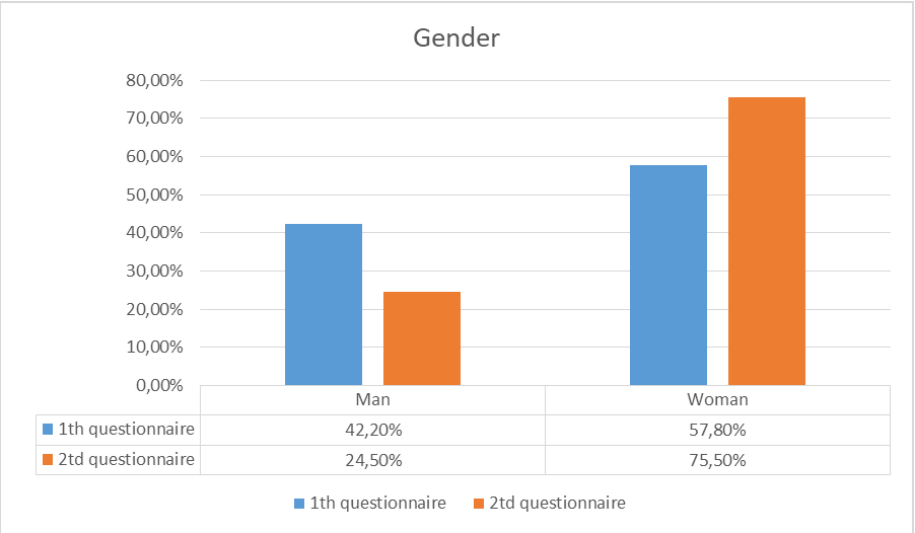


Fig. 1 Gender of respondents

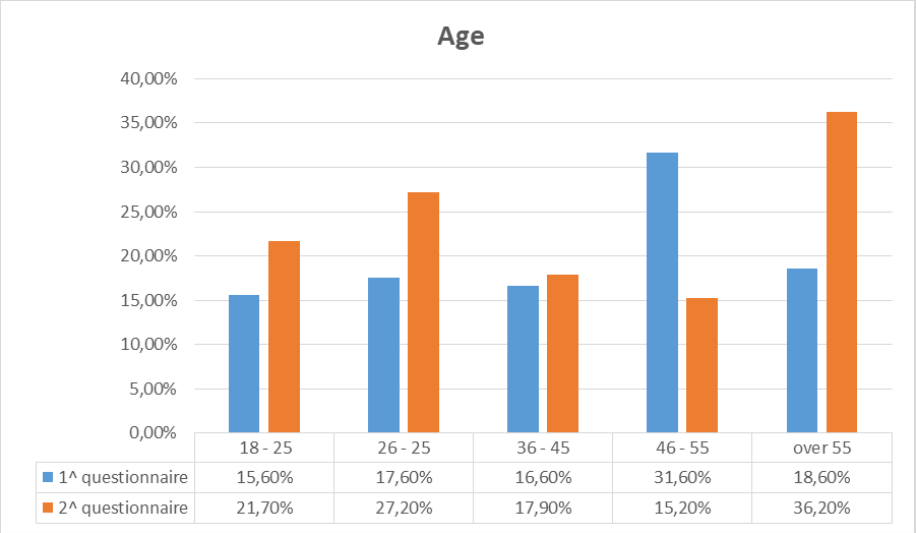


Fig. 2 Age of respondents

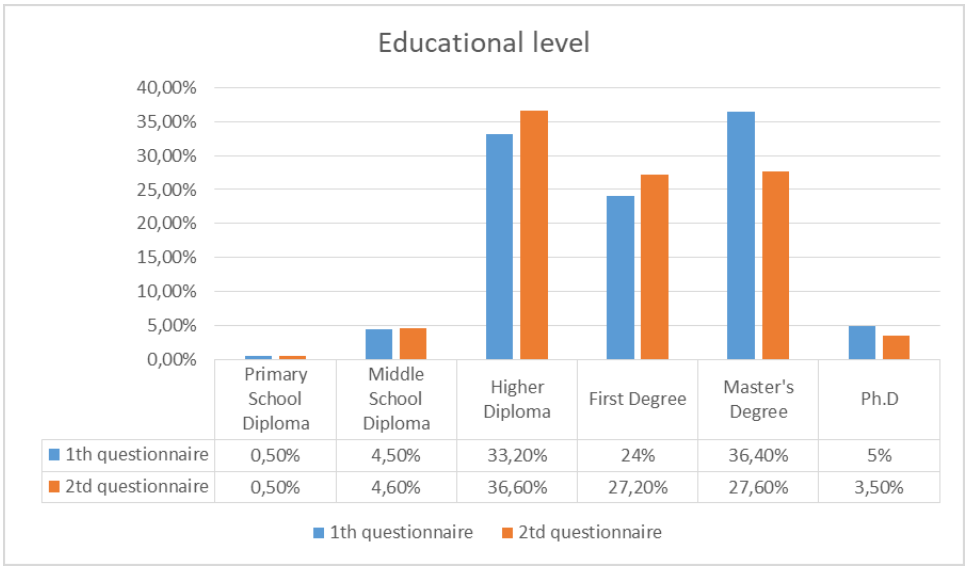


Fig. 3 **Educationl level of respondents**

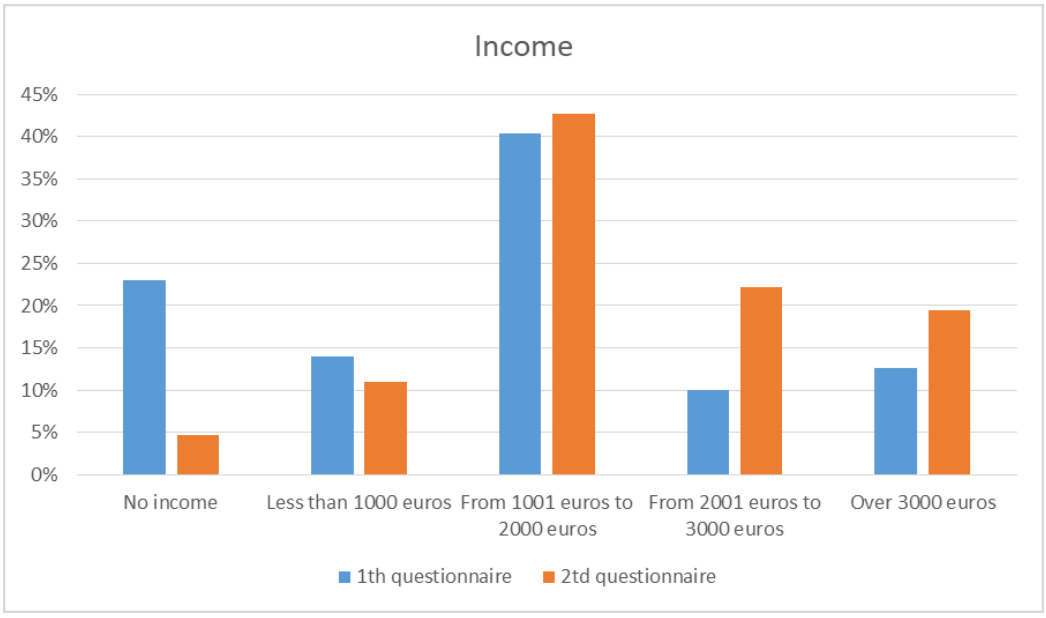
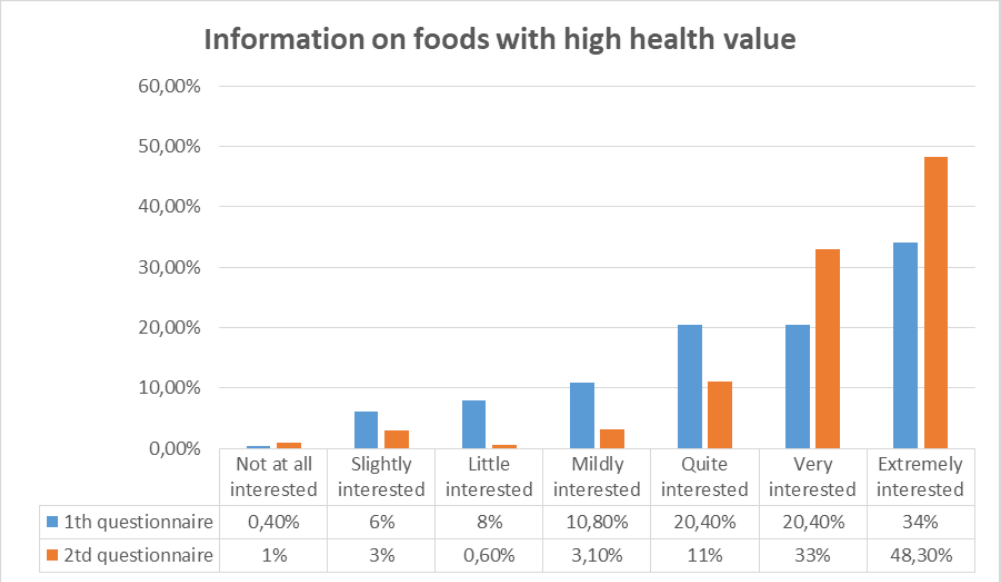
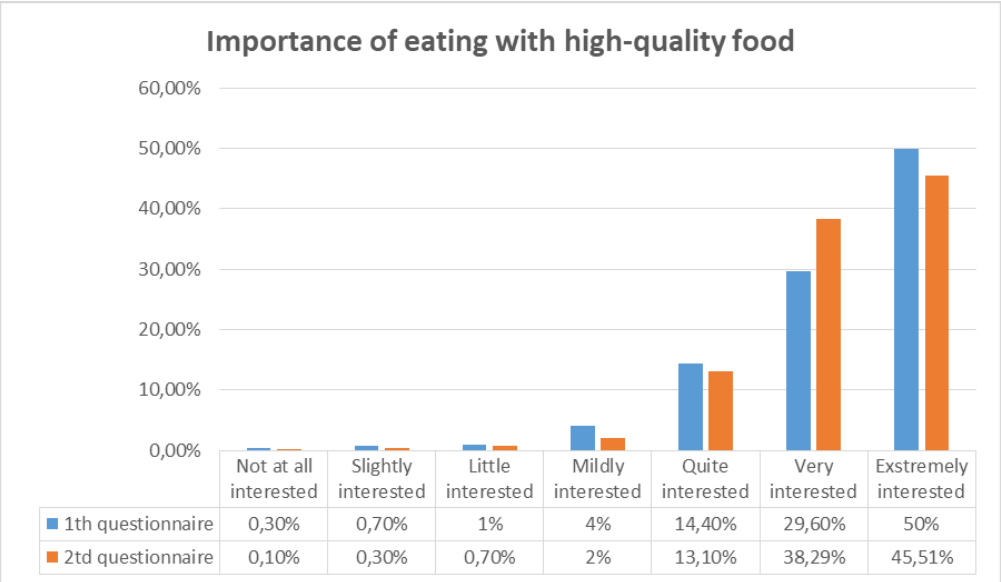


Fig. 4 Income of respondents



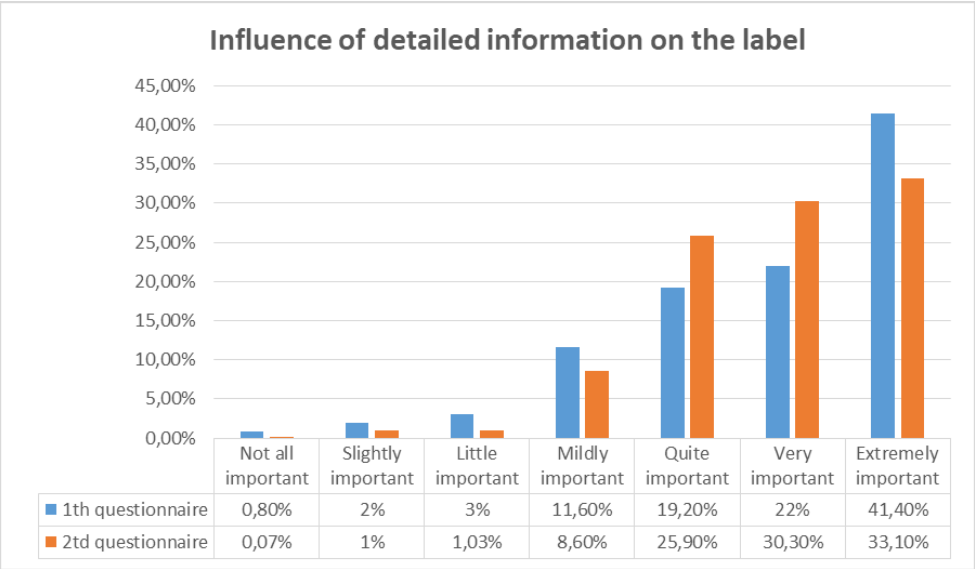
	Not at all interested	Slightly interested	Little interested	Mildly interested	Quite interested	Very interested	Extremely interested
1th questionnaire	0,40%	6%	8%	10,80%	20,40%	20,40%	34%
2td questionnaire	1%	3%	0,60%	3,10%	11%	33%	48,30%

Fig. 5 Consumers' interest in receiving information on high-quality foods



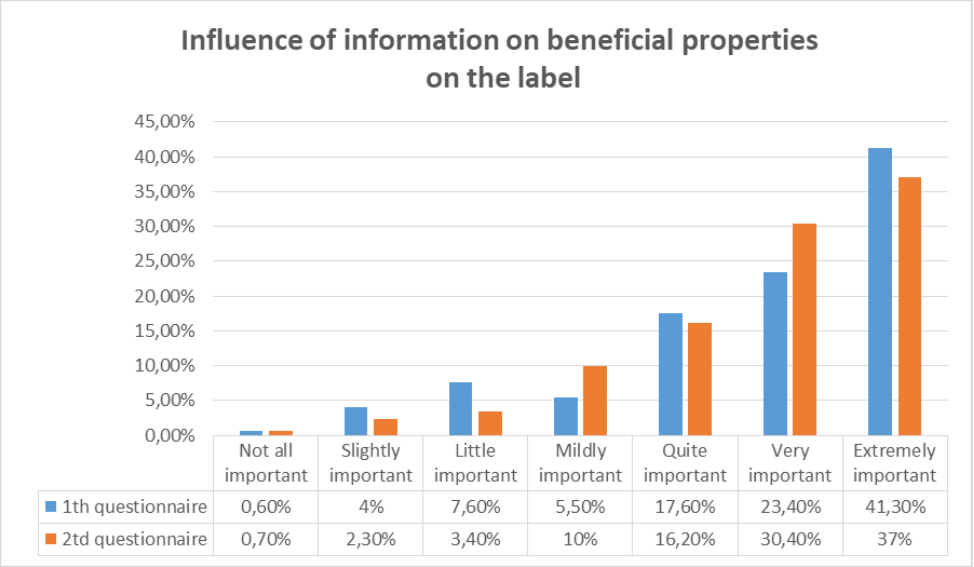
	Not at all interested	Slightly interested	Little interested	Mildly interested	Quite interested	Very interested	Exstremely interested
1th questionnaire	0,30%	0,70%	1%	4%	14,40%	29,60%	50%
2td questionnaire	0,10%	0,30%	0,70%	2%	13,10%	38,29%	45,51%

Fig. 6 Importance for consumers to feed on high-quality foods



	Not all important	Slightly important	Little important	Mildly important	Quite important	Very important	Extremely important
1th questionnaire	0,80%	2%	3%	11,60%	19,20%	22%	41,40%
2td questionnaire	0,07%	1%	1,03%	8,60%	25,90%	30,30%	33,10%

Fig. 7 Importance to consumers of the presence of detailed information on the label (eg list of ingredients, energy value, nutritional content)



	Not all important	Slightly important	Little important	Mildly important	Quite important	Very important	Extremely important
1th questionnaire	0,60%	4%	7,60%	5,50%	17,60%	23,40%	41,30%
2td questionnaire	0,70%	2,30%	3,40%	10%	16,20%	30,40%	37%

Fig.8 Importance for consumers of the presence of indications on the label on the beneficial properties for health

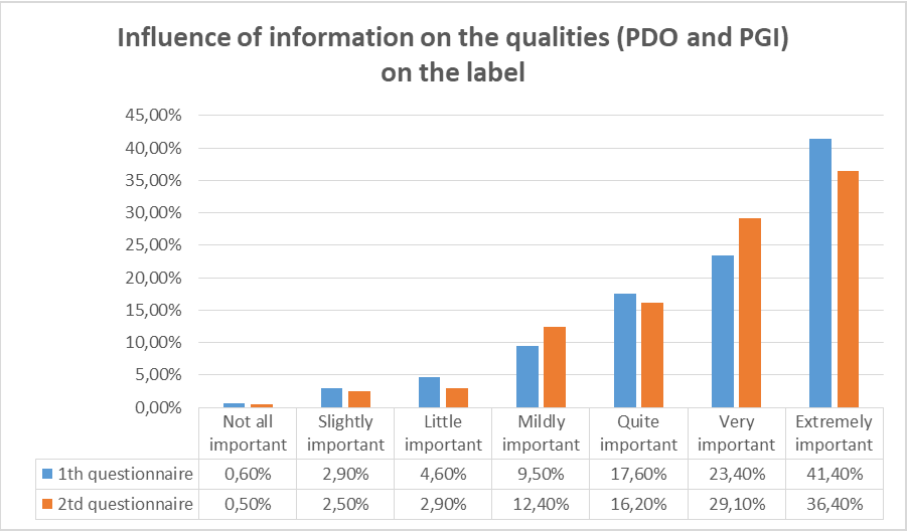


Fig. 9 Importance for consumers of the presence of quality certifications (PDO and PGI)

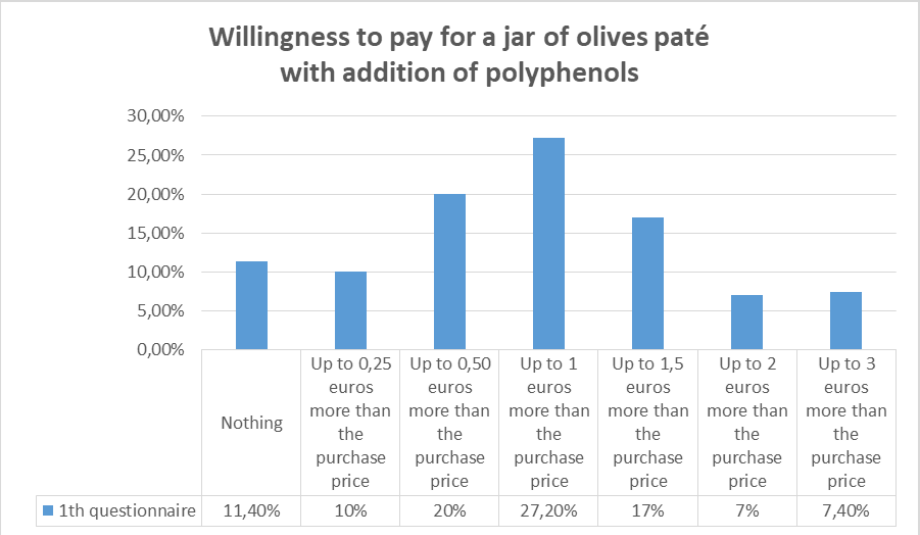


Fig. 10 Availability of consumers to pay more for the purchase of a jar of olive paste with the addition of polyphenols

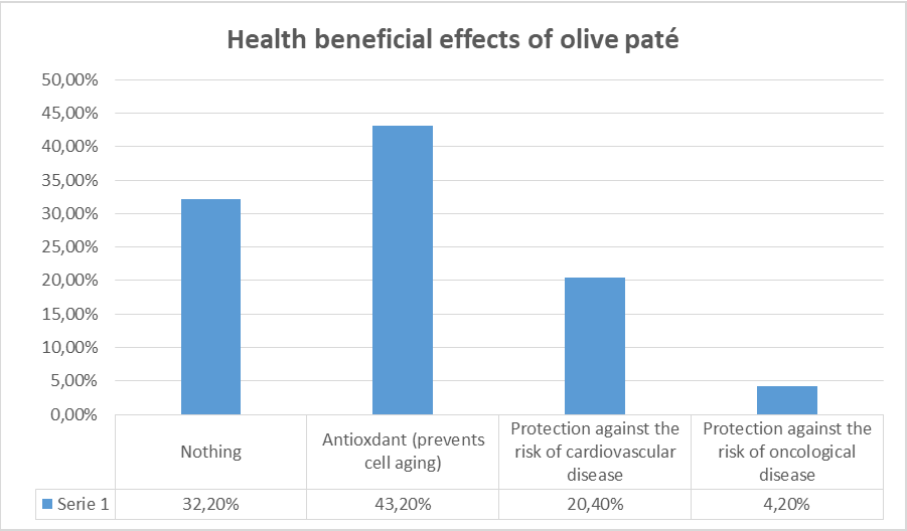


Fig. 11 Beneficial effects on the health of olive patè

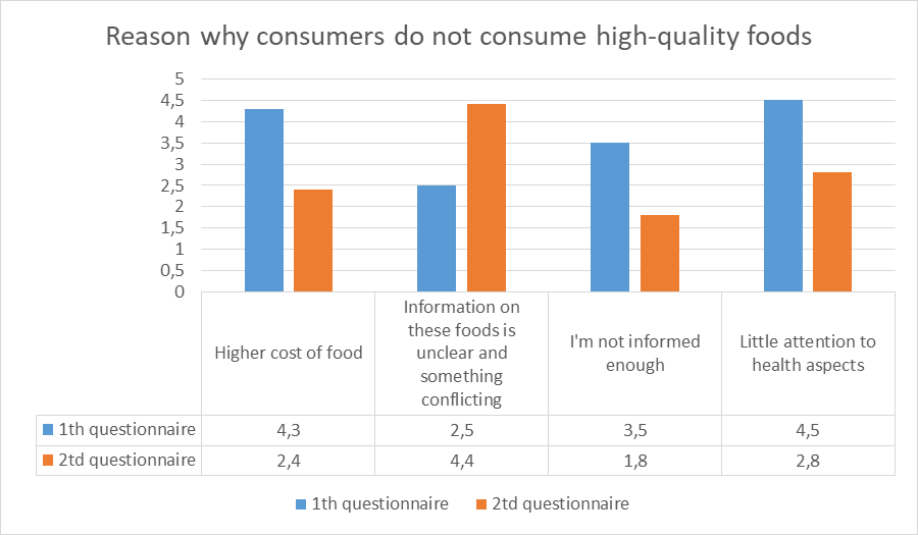


Fig. 12 Reasons why consumers do not consume high-quality foods

CHAPTER 7

STATISTICAL ANALYSIS OF RESULTS

The empirical analysis conducted so far shows the availability of the consumer to spend more on the purchase of olive patè with the addition of polyphenols but do not know how much it would be willing to spend more.

Therefore, a statistical analysis was conducted to understand the price that the majority of consumers consider acceptable as an additional price to purchase a jar of olive paste with the addition of polyphenols.

7.1 Materials and methods

The statistical approach used was that of a linear regression model (OLS = ordinary least squares), with the least ordinary squares even if the variables were not perfectly continuous (rather classified in ranks), however, the model generally allows a most common field of analysis.

7.2 Results

The main target of our analysis is to investigate which might be an acceptable additional price that majority of Consumers would be willing to disburse for buying a polyphenol-added olive paste.

Standard Error (0,74 vs. classes from 0 to >3) and Variance of the sample = Results of interview show that a disbursement of an amount for buying a polyphenol-added olive paste is a too scattered data, whilst more homogenous are the figures related to questions about consuming healthy food, in which answers distribution is more thickened around some values.

Also combining variance between groups and within group i.e. limiting to geographical area (Puglia the most significant in terms of sample size) ols and variance analysis did not provide stronger statistical evidence.

There is a low confidence on the additional price that consumers are available to play for polyphenol added olive pate. Probably more information about the subject must be better spread out among the people interviewed. We assumed to be enabled at applying ordinary least squares with the independent variables

Here some statistical snapshots, providing evidences:

Table 7

Sample 2. N =315

QUESTION- HOW TO KNOW IMPORTANCE OF FOOD EFFECTS ON HEALTH

M6	M5	M4	M3	M2	M1	B	SLOPES AND INTERCEPT
-0,03	0,09	-0,07	0,06	-0,01	0,49	2,47	
S6	S5	S4	S3	S2	S1	SB	STANDARD ERRORS OF M
0,04	0,04	0,04	0,05	0,04	0,11	0,26	
R2	SY						
0,12	0,82						
F	DF						DEGREES OF FREEDOM
7,14	308,00						
STREG	SRESIDUAL						
28,77	206,91						
		ASSUMPTION		INFO ON FOOD EFFECTS VARIABILITY NOT EXPLAINED BY INDIPENDENT VARIABLE VARIABILITY			
		R2 SO LOW MEANS THAT JUST 12% OF VARIABILITY IS EXPLAINED BY MULTINEAR REGRESSION					

Table 8

QUESTION- WILLINGNESS TO PAY FOR HEALTHLY FOOD

M6	M5	M4	M3	M2	M1	B	SLOPES AND INTERCEPT
0,02473295	0,095775	-0,10028	-0,00174	0,011239		1,45	
S6	S5	S4	S3	S2	S1	SB	STANDARD ERRORS OF M
0,05	0,05	0,06	0,06	0,05		0,35	
R2	SY						
0,03	1,10						
F	DF						DEGREES OF FREEDOM
1,97	309,00						
STREG	SRESIDUAL						
11,92	374,26						
		REFUSE THE ASSUMPTION AS F=7,13>4.61		INFO ON FOOD EFFECTS VARIABILITY NOT EXPLAINED BY INDIPENDENT VARIABLE VARIABILITY			
		R2 SO LOW MEANS THAT JUST 12% OF VARIABILITY IS EXPLAINED BY MULTINEAR REGRESSION					

Table 9

QUESTION ON HEALTHLY HABIT

-0,09	0,104682431	-0,065266066	0,021813	-0,030505229	0,379866564	1,674440757	
0,040607617	0,040179221	0,043887436	0,048990061	0,039876608	0,114125799	0,279755916	
0,087685826	0,87	#N/D	#N/D	#N/D	#N/D	#N/D	
4,93383294	308,00	#N/D	#N/D	#N/D	#N/D	#N/D	
22,32230594	232,25	#N/D	#N/D	#N/D	#N/D	#N/D	
#N/D	#N/D	#N/D	#N/D	#N/D	#N/D	#N/D	

M6	M5	M4	M3	M2	M1	B	SLOPES AND INTERCEPT
S6	S5	S4	S3	S2	S1	SB	STANDARD ERRORS OF M
R2	SY						
F	DF						DEGREES OF FREEDOM
STREG	SRESIDUAL						
		REFUSE THE ASSUMPTION AS F=4,93>4.61		HEALTLY HABIT VARIABILITY NOT EXPLAINED BY INDIPENDENT VARIABLE VARIABILITY			
		R2 SO LOW MEANS THAT JUST 8% OF VARIBILITY IS EXPLAINED BY MULTINEAR REGRESSION					

Table 10

SAMPLE 1 N =500
QUESTION ABOUT WILLINGNESS TO PAY MORE FO OLIVE PATE

family members	income	education	gender	dummy5	dummy4	dummy3	dummy2	age	intercept
-0,030386524	0,000162327	0,06012121	0,0795512	0	-0,751581	-0,573757	-0,175666	-0,44605359	-0,56106371
standard error	SE	SE	SE	SE	SE	SE	SE	SE	SE
0,028252169	3,59787E-05	0,034102164	0,0718759	0	0,5341531	0,5037168	0,428978	0,41324383	0,41668625
R2	SE Y								
0,109824511	0,749343743								
F	DF								
4,274027873	485		485	6		we refuse the assumption that variable do have a significancy to explain this answer			
SE-REGR.	SE-RESIDUI								
33,59909319	272,3352818								

From the first analysis carried out, we know that 88.60% of the sampled population is willing to spend a value greater than zero to buy the product.

The results of the subsequent analyzes R2 = 0.12 and also the value of the F test show that the model Y = A1X1 + A2X2 ..... + ANXN + B explains little about the variability of consumer choice, the price that the consumer is willing to spend for the purchase of olive paste with the addition of polyphenols in terms of the independent variables of our model. It follows that the purchasing behavior of the sampled population is not statistically predictable in terms of the precise value of the additional price that the consumer would be willing to spend for the product olive paste with the addition of polyphenols.

Table 11

QUESTION ABOUT IMPORTANCE OF CERTIFICATION

-0,04783442	0,000194804	0,026324043	0	-0,2627824	-0,989125	-0,93433	-1,338449	-1,73326087	-1,2982068	-1,22619	-1,03693047	-2,426997443
0,050641425	6,4703E-05	0,060995008	0	0,12880659	0,9577968	0,9026851	0,7687181	0,74059212	0,74672535	0,701477	0,79676634	1,511728164
0,045411163	1,342852104	#N/D	#N/D	#N/D	#N/D	#N/D	#N/D	#N/D	#N/D	#N/D	#N/D	#N/D
1,648010495	485	#N/D	#N/D	#N/D	#N/D	#N/D	#N/D	#N/D	#N/D	#N/D	#N/D	#N/D
41,60488987	874,5771101	#N/D	#N/D	#N/D	#N/D	#N/D	#N/D	#N/D	#N/D	#N/D	#N/D	#N/D
#N/D	#N/D	#N/D	#N/D	#N/D	#N/D	#N/D	#N/D	#N/D	#N/D	#N/D	#N/D	#N/D
#N/D	#N/D	#N/D	#N/D	#N/D	#N/D	#N/D	#N/D	#N/D	#N/D	#N/D	#N/D	#N/D
#N/D	#N/D	#N/D	#N/D	#N/D	#N/D	#N/D	#N/D	#N/D	#N/D	#N/D	#N/D	#N/D
#N/D	#N/D	#N/D	#N/D	#N/D	#N/D	#N/D	#N/D	#N/D	#N/D	#N/D	#N/D	#N/D

According to the statistical approach used (OLS = ordinary minimum squares), there is no evidence that independent socio-demographic variables (age-gender-imposition status-family size-geographical residence-monthly income) actually influence the

results of the survey, i.e. the answers to the questionnaire, in a linear relationship in both samples.

We have applied the OLS method even if the variables were not perfectly maintained (rather classified in ranks). However, the method generally allows a wider field of analysis.

Finally, all the OLS applied (executed with Excel) with some dependent variables and chosen in both samples, showed a very low R^2 value, which again does not explain the Y variability (the chosen answer) in terms of the linear assumption regression variability.

I do not know the limit price because I do not have a thickening of information, the information is missing. There is a fair heterogeneity of responses from respondents.

The fact that the consumer is willing to consume olives with the addition of polyphenols at a higher price is not statistically supported.

The result of the distribution does not give the certainty of the fact that if I put on the market a product with a higher cost, there will be consumers available for purchase, given the dispersion of information.

Data on responses do not lead to statistically interesting conclusions. The conclusion statistically does not give me the confidence that people are willing to spend little more than a tot or up to a tot to buy olive paste with the addition of polyphenols.

As per the statistical approach used (OLS =Ordinary Least Squares), there is no evidence that the independent socio-demographic variables (age-gender-employment status-family size-geographical residence-monthly income) concretely affect

the survey results, i.e. questionnaire answers, in a linear relationship in both samples.

We applied the OLS method even though the variables were not perfectly continued (rather classified in ranks).However, the method allows in general terms a more widespread field of analysis.

Finally, all the OLS applied (run with Excel) with some few dependent and chosen variables in both samples, has shown a very low R^2 value, which again does not explain the Y variability (the answer is chosen) in terms of the assumed linear regression variability.

Then further regressions were calculated.

In order to carry out more significant results, we filtered some variables in the sample trying to get different effects with partial regression, i.e. not including all the variable but identifying:

1. Social and demographic independent variables
2. Variables describing consumer habits

However in all the case also partial regression, either multidimensional or 1 to 1 do not show a significant linear dependence of Y (willingness to spend more euro for olive path with polyphenol) and the newly aggregated variables. The low level of R2, as well as the test F below the charted figures, make necessarily reject that A1,A2 ……AN will be $\neq 0$.

The same not statistically relevant linear relation appears by regressing on Puglia and Emilia Romagna sample (92% of the original sample).

Probably it will be worth to continue the analysis with a bit different perspective, by detecting more characteristics of the new

innovative product on the market and starting from the fact that 88% of the sample is available to pay greater than zero for buying this healthy product.

1. First example.

OLS regression and choice of consumption on socio-demographic variables

age X4	5. Instruction X3	Monthly income X2	Family size X1	quality certifications: Consumer Habit
				INTERCEPT
-0,048486438	0,00014033	0,026664312	-0,019912265	5,687362268
0,049768755	6,13594E-05	0,060985628	0,052999285	0,324538339
0,019409072	1,347200433	#N/D	#N/D	#N/D
2,449413471	495	#N/D	#N/D	#N/D
17,78224217	898,3997578	#N/D	#N/D	#N/D

In yellow the low values of R^2 and the F test that make us reject HP of a linear relation. And the same result of linear dependence that cannot be verified statistically was on the regression of the variable that concerned the healthy approach in consumption towards socio-demographic variables

2. Second example

How many people are in your family ?	Average monthly income	Employment status	Education level	Age	Sex	INTERCEPT	
-0,09	0,104682431	-0,065266066	0,021813	-0,030505229	0,379866564	1,674440757	
0,040607617	0,040179221	0,043887436	0,048990061	0,039876608	0,114125799	0,279755916	
0,087685826	0,87	#N/D	#N/D	#N/D	#N/D	#N/D	
4,93383294	308,00	#N/D	#N/D	#N/D	#N/D	#N/D	
22,32230594	232,25	#N/D	#N/D	#N/D	#N/D	#N/D	
#N/D	#N/D	#N/D	#N/D	#N/D	#N/D	#N/D	
M6	M5	M4	M3	M2	M1	B	SLOPES AND INTERCEPT
S6	S5	S4	S3	S2	S1	SB	STANDARD ERRORS OF M
R2	SY						
F	DF						DEGREES OF FREEDOM
STREG	SRESIDUAL						
				HEALTLY HABIT VARIABILITY NOT EXPLAINED BY INDIPENDENT VARIABLE VARIABILITY			
		R2 SO LOW MEANS THAT JUST 8% OF VARIBILITY IS EXPLAINED BY MULTINEAR REGRESSION					

After all, the same result had already been seen in the first regressions presented: Regression Price additional olive paste (willingness to spend) on Socio-demographic variables

							SLOPES AND INTERCEPT
M6	M5	M4	M3	M2	M1	B	
0,024732953	0,0957751	-0,100282306	0,0017388	0,0112393		1,45	
							STANDARD
S6	S5	S4	S3	S2	S1	SB	ERRORS OF M
0,05	0,05	0,06	0,06	0,05		0,35	
R2	SY						
0,03	1,10						
							DEGREES OF FREEDOM
F	DF						
1,97	309,00						
STREG	SRESIDUAL						
11,92	374,26						
		REFUSE THE ASSUMPTION AS F=7,13>4.61 R2 SO LOW MEANS THAT JUST 12% OF VARIABILITY IS EXPLAINED BY MULTINEAR REGRESSION					

As mentioned above also limiting the regression only to the regions of Puglia and Emilia Romagna (92% of the sample N = 500 number1) the same result remains, in the sense that no linear dependence is detected between independent variables and choices, consumption habits of identified products such as olive oil and pate with addition of polyphenols.

3. Third example

REGRESSION OF OIL CONSUMPTION ON CONSUMER HABIT LIMITED TO PUGLIA

-	-			
0,027003296	0,008715352	0,014157544	0,011131563	0,032070137
0,053136356	0,032906249	0,031155715	0,047798473	0,051616319
0,004230577	0,976383262	#N/D	#N/D	#N/D
0,293858092	415	#N/D	#N/D	#N/D
1,680852318	395,6295742	#N/D	#N/D	#N/D

CONCLUSIONS

The research started with the idea of knowing if the consumer wanted to spend more for a high-quality food, specifically the olive patè with the addition of polyphenols.

To achieve the goal, after a careful analysis of literature that allowed us to have knowledge of the topic and related issues, we held three separate questionnaires and a market analysis to know the price and the sales trend of olive paste .

Since oil is one of the basic components of olive pâté, a first questionnaire was developed and then conducted to learn about consumer behavior regarding olive oil consumption and the willingness to pay more for oil with certain connotations (healthy and sustainable attributes). Two other questionnaires were then conducted on the consumption habits of products with a high health value, with the relative willingness to pay and on the olive paste, both simple and enriched with polyphenols, with the relative willingness to pay.

The data of these last two questionnaires have been put in relation, but always kept distinct, to extend the number of the sample and to make the information more reliable. In this way the information analyzed was almost 800 and the samples, being inhomogeneous, would have produced generally more statistically reliable results.

The analysis carried out shows that the consumer positively considers both the oil and the functional foods and is willing to spend more on a food with certain additional characteristics that make it highly healthy. In essence, the consumer is interested in foods with high health value and in this case, 88.6% of consumers are willing to purchase. But how much more would the consumer be willing to spend? There is availability but not the amount of

what could be the correct price. So with the help of statistical techniques (ordinary least squares), a first analysis was made by associating every single dependent variable with the independent ones that were thought to allow us to reach the desired result. But on the basis of this statistical approach, there is no evidence that independent sociodemographic variables actually affect the results of the questionnaire research in a linear way and therefore the answers of the questionnaire do not depend on these independent variables.

For this reason we went to examine the sub-variables by filtering some variables in the sample and trying to get different effects with partial regression; for example, not including all the variables but identifying only a few selected by connecting them to see with the analysis of the main components (also known as PCA or CPA) which really affect and we tried to sort consumer preferences to get to a price combination that was statistically supported by data and effectively involved maximizing the utility of the average consumer of the chosen sample.

But the results of the analyzes carried out did not allow us to achieve statistically significant results. Further studies are needed with a somewhat different perspective, detecting more features of the new innovative product on the market and starting from the fact that 88.6% of the sample is available to pay a price higher than zero to buy the healthy product.

In conclusion, on the basis of the most significant empirical evidence derived from the analysis, we can conclude that the consumer is willing to purchase a product with a high health value, in this case, a jar of olive patè with the addition of polyphenols, at a higher price compared to the market. On the other side, the data

available do not allow us to calculate precisely the amount that the consumer would be willing to spend more on his/her purchase.

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