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Sunflower oil innovation, claim assessment and consumer' motivations to accept this food

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ABSTRACT

The food product innovation is advancing under pressure of: 1.st the growing request of innovations in foods products and processing challenging new consumers' needs; 2.nd, the advance in nutrigenomics and its contribution to increase knowledge about the relation between nutrition and food, iii) biotechnologies contribution to create customized food products to satisfy a variety of customers' needs (Hobbs, 2002). An emerging food product category is the nutraceutic food, contributing to satisfy 'nutrients' and 'medical needs; beside it is easier with genomic techniques the original food composition to challenge the customers' needs it must be considered the consumers' adverse reaction for any technique used to change the food product composition. Purpose of this research is to suggest a modification of the sunflower oil composition obtained with genomic technique to change the product from bulk commodity to enhanced specialty food with health claims. The traditional bulk commodity market is based on uniform quality standard, higher volume of production priced at the minimum marginal cost. The specialty market segment demands products with distinctive attributes of higher quality and safety standards, more varieties and sustainability, supported by marketing mix strategies to set up higher prices and better margins according with customers' preferences. A growing importance in consumers' preferences are the combination of nutritional, health and environmental attributes that must be properly communicated with ad hoc messages describing the product's claim. To test the consumers' awareness about healthy claim and willingness to accept these enhanced food products, an explorative SEM analysis is conducted with a questionnaire. The results suggest that the consumer is in favor of the health and environmental care, nevertheless it is opportune to examine in deeper the causes (health claim, technology and environmental impact, communication, culture and others) to convince the consumers to adopt these functional product. The first part of the research is dedicated to analyze the innovations and demonstrate the scientific evidence of the health claims of the modified sunflower oil, describing the role of PUFA (Poly-unsaturated fatty acids). It is discussed the metabolic pathway of the eico-esanoid EPA and DHA generated from modified sunflower oil, responsible of benefic effects on the human metabolism. The second part is dedicated to the inference about the consumers' acceptance of this functional sunflower oil using SEM model. It is our conviction that this procedure will open new perspectives of food innovation in creation of nutrition and healthy food to satisfy the growing population in the world

Keywords: Sunflower, genomics, functional food, eicosanoid, SEM, preferences and market

INTRODUCTION AND RESEARCH BACKGROUND

The French school emphasizes the principle of nutritional synergy: "The wider the spectrum of nutrients in natural composition, the better is the assimilation and their efficacy". A similar concept is expressed for the functional food elaborated by the Japanize scientists that play a systemic action of the components in the

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human metabolism, procuring health effects. Functional foods may be modified or enriched with naturally occurring substances with specific physiologically preventative and/or health-enhancing effects (Poulsen, 1999). The positive interaction with one or more functions of the human body goes beyond the normal nutritional function and offers a substantial contribute to ameliorate the state of health, well-being, reducing as well the risk of illness (Geiser, 1999). This food category includes the vegetable oils obtained from sunflower seeds that in these last years has been modified to produce higher quantity of oleic acid (MUFA) combined with polyunsaturated fatty acids (LC-PUFA), the precursors of eicoesanoid Ω-3 and Ω-6 and tocopherol (Vit. E). Medical and clinical researches have proven their involvement in the synthesis of prostanoides (prostacycline, prostaglandine and thromboxanes) used in different metabolic functions responsible of healthy effects: immunity, antioxidants, anti-estrogenics, anti-inflammatory, anti-trombotic, immunomodulatory, anti-carcinogenics and others. According to the European Food Safety Authority (EFSA), the higher content of PUFA (and metabolites ω3 and ω6) and vitamin E contained in higher quantity in sunflower oil (Helianthus Annuus) have positively contributed to increase the healthy blood cholesterol (HDL) concentrations, to promote the children's growth, and the association with tocopherol (FEDIOL) has enhance the antioxidant action. As the consumers are becoming growingly aware of these functional properties, the seed oil processing industry is growingly interested in the creation of oils targeted to this emerging market segment. The gut microbiota influences the bioavailability and the effects of PUFA by stimulating the growth of beneficial bacteria, playing prebiotic-like effects. (Cencig and Chingwaru, 2010). Recent biotechnologies (NGS) can create in shorter time new sunflower varieties producing the desired mix of PUFA without violating the intra-genetic breeding principle, that excludes the introduction of genetic traits from other species. The 51 wild species, 14 of them annual and 37 perennial offer a great amount of germoplasm biodiversity for inter-crossing breeding of wild and cultivated sunflower; the genome editing and CRISP-CAS9 make possible to select the proper genetic traits to create new varieties targeted to the scope. (Hladni et al.,2008; Skoric et al, 2008). However the consumer' opinion in the EU is still perceive the traditional genetic techniques as safer and healthier with respect to recent genomic technologies, even if scientific studies demonstrate that they do not violate the nature of the original oil seed product. To understand the functional role of PUFA, it is reported in figure 1 the metabolism of linoleic acid (La) and alpha-linolenic acid (ALA) the two essential unsaturated fatty acids that the human organism is unable to produce. They are the precursors of the eicosanoid DHA and DPA responsible of the formations of prostanoides that have important roles in the human metabolism.

Fig 1 – Metabolic pathway of LA and ALA precursors respectively of eicosanoid Ω6 and Ω3

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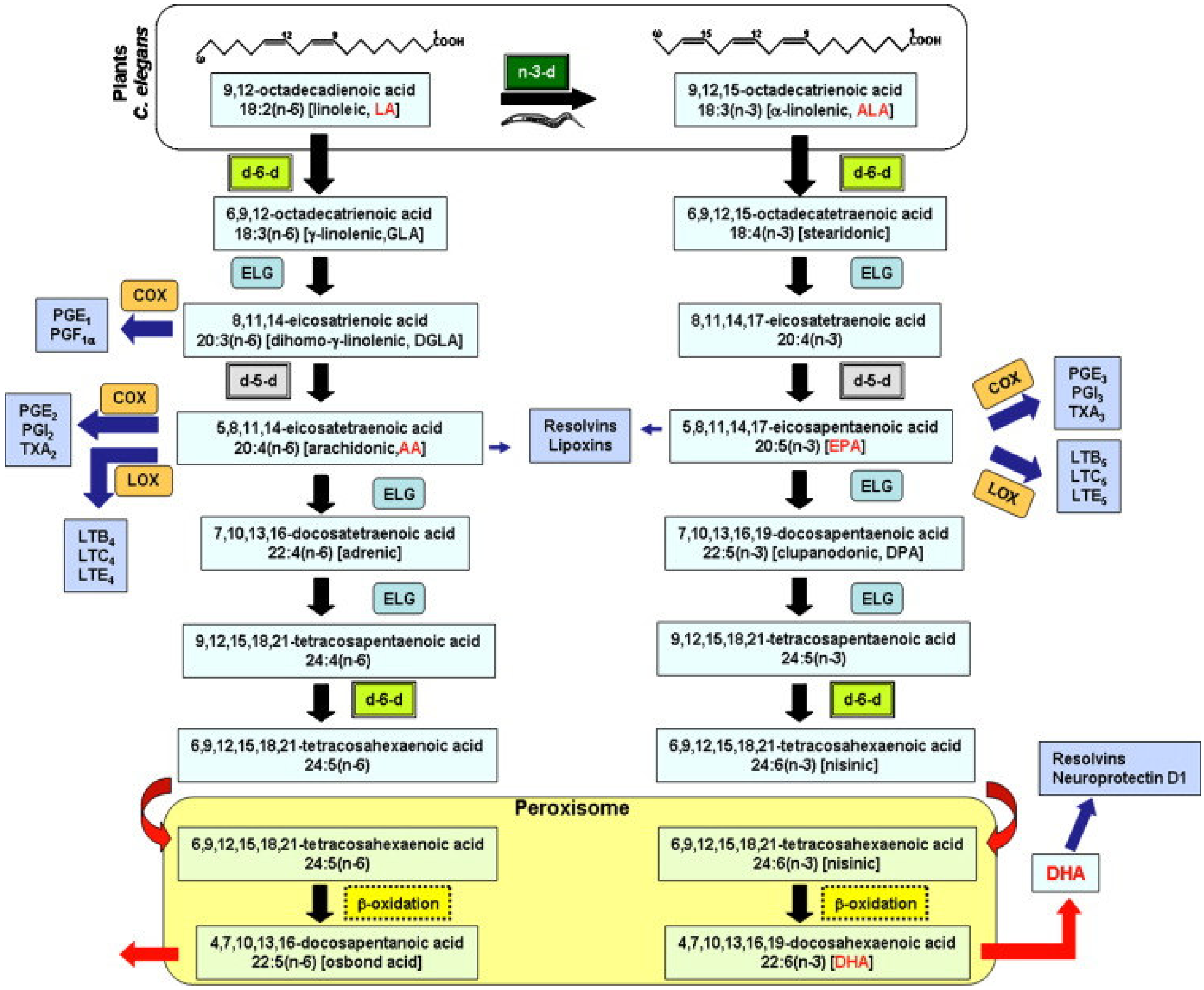

The Linoleic acid (LA, C18:2, n-6) produced in consistent quantity by sunflower can be transformed into alpha linolenic acid (ALA, C18:3, n-3) with intervention of Δ15 desaturase, then the LA can is the precursor of the all eicoesanoid generated by the two metabolic pathway reported in fig. 1. The metabolic pathway of LA produces the Arachidonic acid that generates the eicosanoid derived from n-6 LC-PUFA namely DPA (Docosapentaenoic) entering into metabolic functions but they are potentially inflammatory. From the metabolic pathway ALA is derived the eicosanoid n-3 LC-PUFA named EPA (Eicosapentaenoic (C20:5 n-3) and DHA (Docosahexaenoic C22:6, n=3) components of the healthy cell membranes, playing cardiovascular protective function, anti-inflammatory and essential components of lipids in cell membranes with structural functions. (Ruiz Lopez et al., 2015). Medical and nutritionists are making progresses in the knowledge about the correlations between functional oil components and their metabolic effects.

Other clinical studies suggest the main functions of conjugated LA are antithrombotic, immune-modulation and contribute to the formation of lean mass of muscles. The second essential polyunsaturated fatty acid is the α-linolenic acid, precursor of the Ω3, belonging to the n-3 family (ALA 18:3 n-3). The human organism synthesizes albeit with a modest efficacy the ALA, precursor of EPA (eicosapentaenoic acid) and DHA (docosahexaenoic acid), important for anti-inflammatory, hypo-triglyceride-, hypotensive and "fluidizing blood" functions, which makes them a real help for the prevention and treatment of cardiovascular disease[1]. The medical guidelines recommend a balanced ratio between Ω6/ Ω3 ranging from 10/1 to 2/1, rather than the absolute amount of each single PUFA. A range from 450 mg/day to 650 mg/day of combined EPA and DHA is suggested as the optimal daily intake. The sunflower oil contains also significant amount of liposoluble vitamin E, a chemical compounds of tocopherol group. The alpha-tocopherol is the most powerful form of vitamin E with high biological and nutritional value. The most important claim of

[1] (See http://www.my-personaltrainer.it/nutrizione/acido-linolenico.html)

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Vitamin E is the prevention of oxidation of PUFA (lipid peroxidation), a powerful immune stimulant, to prevent and treatment of heart disease such as coronary thrombosis and heart attack, in which the vessels are blocked by blood clots causing part of the heart deprived of its blood supply.

Following a diffused scheme, functional food are classified in five different categories:

i) Non-altered products: foods naturally containing increased content of nutrients or components;

ii) Fortified products: increased content of existing nutrients or functional components;

iii) Enriched products: Added with new nutrients or components not normally found in nature;

iv) Altered products: Replacing existing components with beneficial components;

v) Enhanced commodities: Changing raw commodities to alter nutrient composition.

The proposed innovation of sunflower oil mix with enhanced PUFA, MUFA and Tocopherol obtained with traditional breeding and more recent CRISP techniques allocates this product in the 2.nd or 4.th group. The legislations of United Nations Organizations, FAO / WHO, the Codex Alimentarius, the Council of Europe, the EFSA and the national regulatory bodies are setting out codes of conduct for these products to put on the packaging, only claims with scientifically proven health claims. European labeling legislation (1924/06) prohibits the attribution to any food the property of preventing, treating a human illness or referring to such properties. In the absence of a clear directive on this subject, the Member of the European Union have given different interpretations to the existing labeling legislation. For instance, the use of fatty acids is allowed by many EU members: in Belgium their use must always be followed by a notification; Denmark and Finland permit their use only if naturally occurring and in France they can be added only to dietetic foods. The demand for functional foods in Europe is steadily growing: according with the Food Safety Authority (EFSA), the high content of linoleic acid, essential fatty acids and vitamin E makes this oil an ideal food for a healthy diet.

SUNFLOWER BREEDING AND VARIETIES.

Over the past 20 years, breeders have made significant progresses in creating new sunflowers hybrids with different compositions of fatty acid namely: i) the mono-poly unsaturated type: myristoleic (C 14:1), palmitoleic (C 16:1), oleic acid (C 18:1, 16-80%), linoleic acid (C 18:2, 68-72%); ii) the saturated fatty acids: Palmitic (C 16:0, 6%), stearic (C 18:0, 5%) and minor amounts of myristic (C 14:0), arachidic (C 20:0), behenic (C 22:0). The most important mutant currently traded is the high oleic acid (80-90%) having benefic nutritional effects and implemented oxidation stability. The modern biotech methods allowed to discover the mutant gene loci responsible of increased composition of essential fatty acids LA and ALA and tocopherols; this will allow a potential development of new functional sunflower varieties with oil composition targeted to different consumers' needs.

Tab. 1 - Description of sunflower oil components with genes responsible of metabolism and claim

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Functional component	Quantity %	Gene name and function	Claim
Palmitic (SFA)	4-7		Potentially dangerous in higher quantity
Stearic (SFA)	4-5		Potentially dangerous in higher quantity
Oleic (MUFA) Traditional	20-30		Good for health, antioxidant
Oleic (MUFA) High oleic	80-90		Higher nutritional effect, longer shelf life
Oleic (MUFA) Mid oleic	55-75		Positive nutritional effect
Linoleic (LA-PUFA)	15-70	FADS1- Δ5-desaturase.	Precursor of eicosanoid Ω6 and ALA
Linolenic (ALA-PUFA)	0-1	FADS2-Δ6, Δ8, Δ4 des. FADS3- Δ?-desaturase SD Δ6 desaturase MAΔ6 desaturase MA Δ5 desaturase Sa Δ4 desaturase Sd Δ17 desaturase Ma Δ6Elongase Pav Δ5Elongase	Precursor of eicosanoid Ω3
DHA-EPA from ALA	Dose 220/430 mg/day		Protect from hearth disease, capture free radicals
DPA from LA	500-1000 mg/day		Protect from hearth disease, capture free radical
∴α - tocopherol /Vit E)	435 mg/kg		Support the daily requirement of vitamin E; modulates proteins, such as kinase, lipoxygenase and phospholipase; modulate the transcription of the genes involved in the cell signaling and regulation of the cell cycle
β - tocopherol			Good for health, longer shelf life
γ - tocopherol	93 mg/Kg		the most potent free-radical remover NO(X); strong anti-inflammatory activity;

The functional food oil market is a resource-intensive, for the amount of investments and time required for basic research, technology development, trade strategies, length of time for product approvals, developing and resourcing marketing strategies. The health-promoting ingredients are still being tested for their long-term effects on health or face discrepancies with regard to scientific opinions.

The complexity of this product requires also the building of supply chain partnerships among input suppliers, farmers, research units, food processors and retailers. There exist opportunities for strategic alliances or joint ventures and the need for a consistent supply of functional ingredients through contracts or special supply arrangements. Today, supply chain participants perceive the functional food industry as an opportunity to gain market share through improved margin distribution, customer loyalty and reduction of transaction costs. Nevertheless, the sunflower oil industry structure is still characterized by higher concentration dominated by larger companies (Bunge, Cargill) oriented to bulk market. At the other side market problems could arise to afford the niche market seed oil for the difficulty to coordinate the trade relations with a large network of retail stores an problems of setting the price. Although the modified sunflower oil composition possesses unique nutritional and healthy characteristics, conventional seed oils still occupy the largest space in the shelf of retail stores (Hobbs, 2002).

ECONOMIC ANALYSIS: THE CONSUMERS’ ACCEPTANCE OF THE FUNCTIONAL SUNFLOWER OIL.

A large number of researches suggest that the demographic characteristics play a contradictory role about perceptions of health claims of functional foods and their consumer acceptance (Verbeke et al., 2009). Significant predictors of functional food consumption are related to consumers‘ health motivation, perceived diet effectiveness of products, and knowledge about nutrition (Landström et al., 2007, Petrovici

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& Ritson, 2006, ; Urala et al, 07). There is evidence that consumers most likely to have a positive attitude toward functional foods, are the older people who may have faced chronic illness (Verbeke, 2005). About income, market is dominated by well-off consumers, arguing that packages of functional foods are designed to be attractive and functional for long term conservation to gain premium price. The predominant issue is the health care that solicit the consumer attention for these functional products. Despite the overwhelming interest in and increasing consumption of functional foods, very little is known about how consumers perceive these products (Herath et al., 2008). Most of the studies suggest that the consumers' rational decision making prevail over the emotional approach when purchasing health-claimed foods but the functional properties are difficult to be understood without adequate scientific background (Verbeke, 2005). Other researches divide the consumers of functional food in two categories:
i) the Harmony-oriented consumers that perceive the co-existence with nature, and address their preferences for natural food procuring health benefits and reject any manipulation at production/processing level;
ii) the Mastery-oriented consumers, positive about the active and self-assertive manipulation of social and natural environment and therefore may exhibit positive attitudes toward manufactured functional foods (Niva, 2003).
Because the consumers seek healthy foods for a variety of reasons and have different preference patterns, the functional foods were designed specialty food for niche markets, rather than for a larger marketplace. The difficulty to understand properly the functional activity has induced many countries to regulate the health claims reported in the label to convey relevant information about health benefits of foods with specific functional formulations. The communication message has a greater impact on changing consumers' knowledge and attitudes and reshaping their decision-making (Verbeke, 2008). Health claims are indeed key factors for the development of a successful market for functional foods, especially if the product is made with novel ingredients, or the health benefit is not widely known or properly understood. Functional food claims are generally understood as “credence attributes” that cannot be verified by normal consumers because too complex to be understood; in fact they require deeper scientific background in medicine and physiology to understand the metabolism and action. Hence the consumers place little value on non-verified claims with generic descriptions of procured benefic effect and trust more on the source of information for a positive attitude toward food products. One way of answering to the consumers' request of neutral information is to give to a public agency the authority (see reg UE 1924, 07) to regulate the health claim reported in the label for, which validate the thoroughness of credence attributes. Moreover, the majority of studies about consumer behavior and attitudes toward functional foods are focused on developed countries such as the US, Canada, Finland, Australia, and Sweden, leaving out other potential customers in EU countries.

RESEARCH FRAMEWORK AND METHODOLOGY

The second part of this work is dedicated to the empirical analysis about consumer's perception of the modified sunflower oil food by studying the behavioral intention using a SEM (Structural equation model) that is used to test these relations between non observed latent variables (LV - constructs) and observed indicators correlated to these LV . The SEM model in Lisrel notation is composed by three equations:

$\eta = B\,\eta + \Gamma\,\xi + \zeta$

$y = A'\eta + \varepsilon$

$x = A'\,\xi + \delta.$

Eq. (1) is called the latent variable (or structural) model and expresses the hypothesized relationships among the constructs in one's theory. The m X 1 vector η contains the latent endogenous constructs and the n × 1 vector ξ consists of the latent exogenous constructs. The coefficient matrix B shows the effects of endogenous constructs on each other, and the coefficient matrix Γ signifies the effects of exogenous on endogenous constructs. The vector of disturbances ζ represents errors in equations. Eqs. (2) and (3) are factor-analytic measurement models which tie the constructs to observable indicators. The p x 1 vector y contains the measures of the endogenous constructs, and the q X 1 vector x consists of the measures of the exogenous indicators. The coefficient matrices A^y and A^x show how y relates to η and x relates to ξ,

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respectively. The vectors of disturbances ε and δ represent errors in variables (or measurement error). Generally (but not always) the measurement model possesses simple structure such that each observed variable is related to a single latent variable. The increasing awareness of the relationship between food and health has addressed the demand toward food providing health benefits other than nutritional. FF are a representative category of specialty food product with their consumption becoming more than occasional, as their daily intake is needed to fulfil the metabolic need.

Preliminary observation to the empirical analysis: the change in consumer preferences from mass products to specialty food products, reflect the interaction of different factors: health and environmental care, education, income and others driving consumers to the search for higher quality products as ipo-caloric, disease prevention, relational, ethical and values. However, health claims can affect consumers' decisions only when they are clearly understood (EU reg. 1924/07).

The aim of this second part is to explore the consumers' attitudes driving to a behavioral intention (BI). Consumers purchase sunflower oil products with functional properties if the overall satisfaction from such food is higher compared to other available seed oil (soybean, rapeseed, corn, peanut and other). This framework is proposed to test the capacity of Health (HM) and Environmental motivations (EM) to convince the consumer to use functional sunflower oil. To a sample of selected consumers was submitted a questionnaire to test the perceived quality of this oil, and the consequent Behavioral intention (BI). The most represented categories of participants to the experiment were students and employees at the University of Udine.

Health motivations expresses the readiness to undertake health actions (Becker et al., 1977). Health-conscious consumers were motivated to improve and/or maintain their health and quality of life (Hartmann, Siegrist & van der Horst, 2013). Previous research identified interest in health as a primary reason for the purchase of organic food (Grankvist and Biel, 2001; Lockie et al., 2002). A measurement scale was proposed to test this construct as antecedent of perceived quality.

Environmental motivations in numerous studies were proposed as determinants of food purchase. Some authors examined the relationships between the natural environment and consumer behavior (Diamantopoulos et al., 2003), others focused on marketing strategies (Gregori e Nassivera, 2014), other on customer satisfaction (Rosa and Nassivera, 2013) public initiatives and macro marketing (Kilbourne & Carlson, 2008). Among environmentally significant activities, the production, trade, and consumption of food products were identified as crucial contributors to numerous environmental problems (Marques & Almeida, 2013). Several studies argued that processes involved throughout the entire life cycle of food products, from production to consumption, contributed to the emissions of greenhouse gases, farmland erosion, excess sewage, avoidable waste, and loss of species, to name only a few of the negative consequences (Jungbluth, Tietje, & Scholz, 2000. A theoretical model to analyse the relationships between latent constructs was proposed; the following figure 2 shows the theoretical framework of the proposed causal relationships between Health Motivations (HM), Environmental Motivations (EM), perceived attributes of product quality (PQ) and Behavioral Intention (BI).

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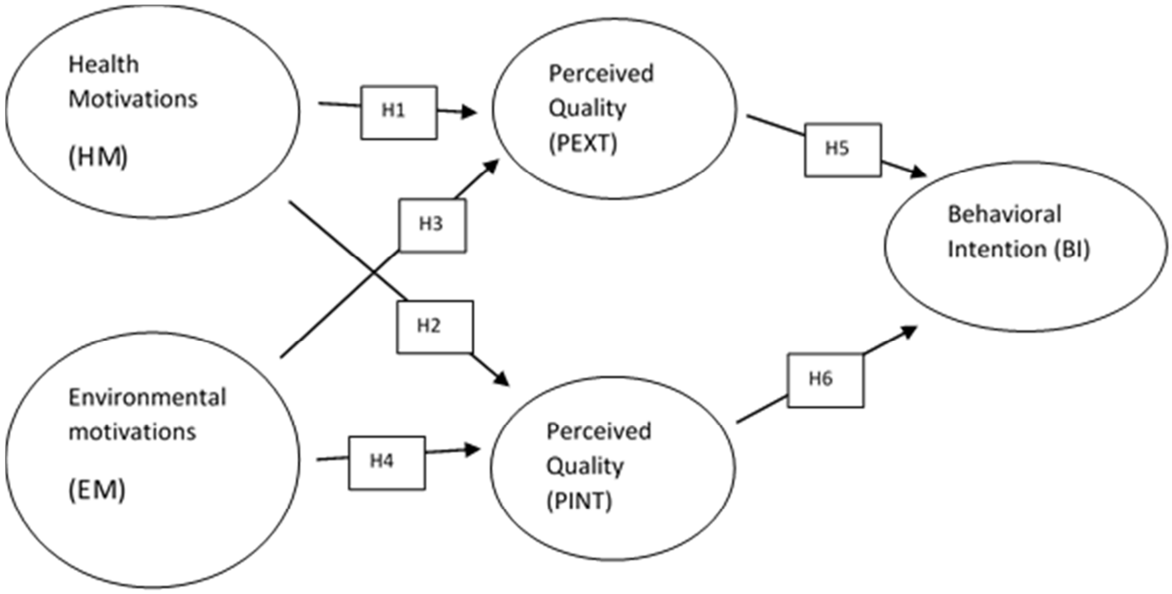

Figure 2: the conceptual proposed model of customer intention

Considering a measurement scale for each latent construct, the aim of his work was to test the following hypotheses:
hypothesis 1 (H1): Health Motivation (HM) had a significant impact on Extrinsic attributes of perceived product quality (PEXT);
Hypothesis 2 (H2): Health Motivation (HM) had a significant impact on Intrinsic attributes of perceived product quality (PINT);
Hypothesis 3 (H3): Consumers' Environmental motivations (EM) had a significant impact on Extrinsic attributes of perceived product quality (PEXT);
Hypothesis 4 (H4): Consumers' Environmental motivations (EM) had a significant impact on Intrinsic attributes of perceived product quality (PINT);
Hypothesis 5 (H5): Extrinsic attributes of perceived product quality (PEXT) positively affected consumers' behavioral intention (BI);
Hypothesis 6 (H6): Intrinsic attributes of perceived product quality (PINT) positively affected consumers' behavioral intention (BI)
A questionnaire was submitted to a non-probabilistic sample of students and employees consumers of the University of Udine, to gather data and information about preferences for this proposed functional oil. A number of 417 questionnaires were collected between April and June 2017, structured in several sections exploring information about personal and shopping habits, socio-demographic features, and others. A measurement scales for each construct proposed in the theoretical model, was measured using a Likert scales (seven divisions), according with the indications of the literature. The majority of respondents were females, aged between 30 and 50 years (63%), with high school degree (37,8%), a monthly net income between one thousand and two thousands euros (34%), the most frequent salary in this country. Usually the seed oil purchases were made at the supermarkets and hard discount (68%).
Data analysis were made by using Exploratory Factor Analysis (EFA) and Structural Equation Modelling (SEM). The exploratory factor analysis, with the Varimax oblique rotation, allowed to identify the five latent constructs of the model (HM, EM, PEXT, PINT and BI). This procedure reduced the original variables in four latent factors, obtained as a linear combination with minimum loss of information. The reliability of each factor was analyzed by the Cronbach's α, and respect the threshold value equal to 0,7. The Structural Equation Model (SEM) was implemented using the LISREL 9.1 software. The analysis allowed to test the hypotheses imposed in the proposed causal model. The statistical evaluation used several fit measures, suggesting a reasonably good model fitting according to the quoted literature. The existence of direct causal effects among the latent variables HM, EM, PEXT, PINT and BI was confirmed with the fit indexes from the SEM analysis. The incremental fit indexes gave an indication of the good adaptation of the conceptual model: 0.86 for NFI and 0.90 for the CFI. The analysis of the indexes of the residues also

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provided useful insights about the model fit. The RMSEA value equal to 0.09 was also an acceptable indicator of the model adaptation.

RESULTS

Among the reported six hypotheses, explored only two were not supported (H4 and H6) about the perceived quality of the environment. The relationship between Health Motivation (HM) and perception of Extrinsic attributes about product quality (PEXT) were positive and significant (γ = 0.21, t = 2.45), supporting H1. The relationship between Health Motivation (HM) and perception of Intrinsic attributes about product quality (PINT) was positive and significant (γ = 0.25, t = 3.01), supporting H2. Perception of Extrinsic attributes about product quality (PEXT) was positive and affected the consumers' behavioral intention (BI) (β = 0.68, t = 5.18), supporting H5. Consumers' Environmental concerns (EM) had a significant impact on perception of Extrinsic attributes about product quality (PEXT) (γ = 0.28, t = 3.01), supporting H3. Path analysis is described in the figure 3, with its standardized estimates of causal relationships between latent constructs and their indicators.

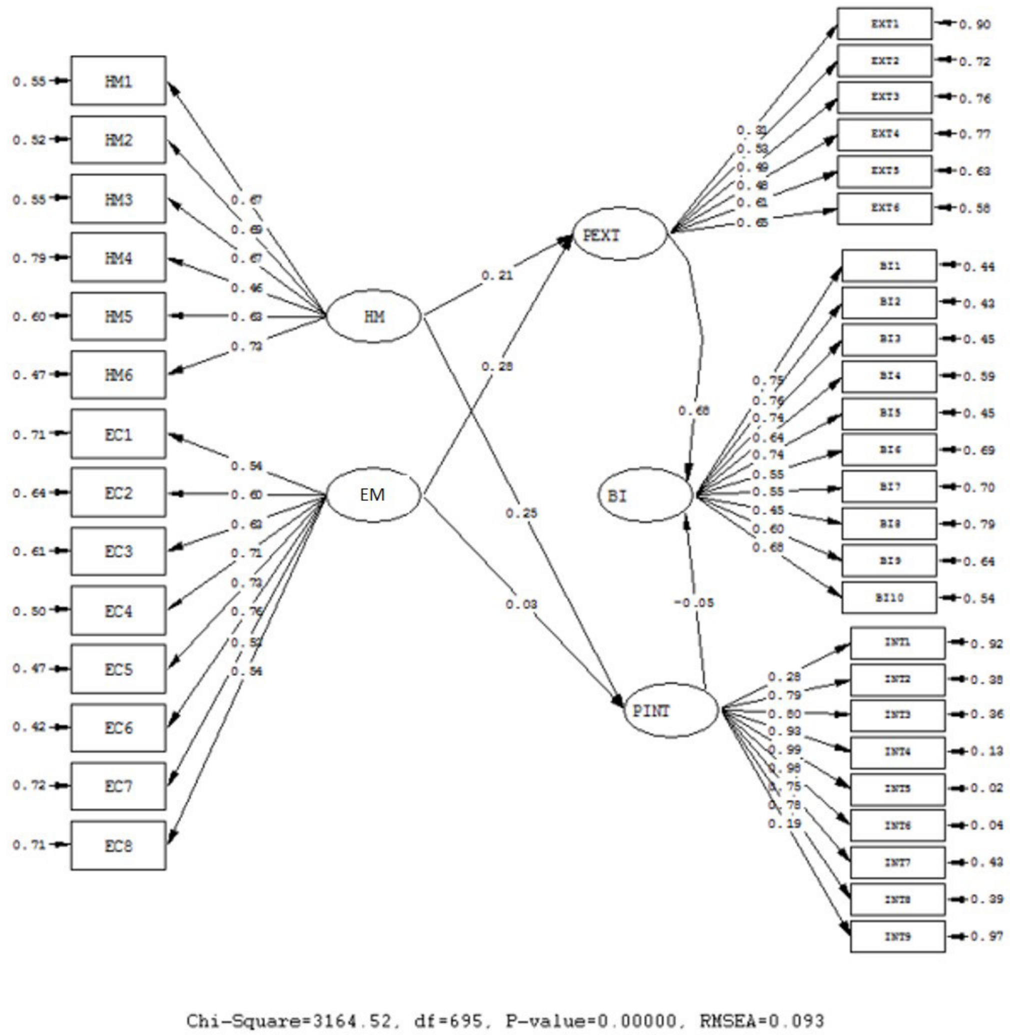

Figure 3: path analysis of the proposed model

In supporting hypotheses, the model depicts a particular reactivity of consumers to this kind of product: a significant attention to issue of health motivation, have a positive influence on perception of extrinsic attributes of perceived quality, and a consequent positive attitude to behavioral intention to buy. Retailers of this kind of food product can make their marketing strategy accordingly to the reactivity of the

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consumers not only for aspects related to a healthy product, but also to attributes of environmental sustainability.

CONCLUSIONS

The model provides evidences for the consumers' acceptance of this modified food product and suggests these comments:

i) processors must consider the consumers perceptions with a good combination of intrinsic/extrinsic attributes (intrinsic oil attributes, based on the different combination of oils in the product, reducing the hydrogenation, using cold extraction), promoting the image of oil produced with environmental friendly techniques, and other marketing strategies using brand, price, communication, innovative materials for packaging;

ii) label is a valuable communication tool used for communicate the health claim information to consumers avoiding too technical language and focusing on those attributes of credence quality Better if functional information will be provided by independent source (Paul et al, 2012);

iii) health claim must be formulated according with the reg 1924/06 of EU parliament
'Health claim' is any claim that states, suggests or implies that a relationship exists between a food category, a food or one of its constituents and health. 'Reduction of disease risk claim' means any health claim that states, suggests or implies that the consumption of a food category, a food or one of its constituents significantly reduces a risk factor in the development of a human disease. Any claim made on a food's labelling, presentation or advertising in the EU must be accurate, clearly understood by consumers. In the naming of the substance or category of substances, there is a description or indication of a functionality or an implied effect on health substantiated by medical and scientific evidence. Healthy claims are reported in a list of EFSA adopted in 31 /01/2010. Healthy claims will be generically reported in the label using conventional terms easily understood by consumers as anti-oxidant effect, anti-inflammatory, blood pressure regulatory and other similar expressions. Other medical or scientific description about metabolism of LA and ALA or breeding techniques that could be misleading and generate consumers' aversion should be avoided.

iv) sunflower oil is a specialty food product and can be effectively traded in the retail store as well in large chain store market. For this purpose the product must be elaborated with a combination of intrinsic/extrinsic attributes and the product must be traded with adequate market strategies focusing on the health claims.

v) retailers intended to increase the sales of sunflower oil must emphasize a specific industrial or retail brand focused on perceptions of credence quality.

vi) prices will be selected according with the size of the planned market segment, packaging and label. The higher price reference is at the present for the extra virgin olive oil.

vii) the chain value margin must be higher for an equivalent quantity and costs of traditional product to compensate the research investments occurring during the experimental period.

Network: the complexity of the supply chain is due to a number of functions: product, processing, storage, exchange, financing, logistic, transport coordination, quality control, marketing, information sharing, risk management and others. These functions are managed by different subjects of the network including actors at different levels of the chain. Different stake-holders involved in the supply chain are producers (growers and contract farmers), collectors, processors, dealers, wholesale/retail traders, consumers, data base managers and government agencies. Units are represented by farms, processing industry with private and companies involved, wholesaler and retail chain. The purpose is to increase the volume of production, product differentiation, coordination of the exchanges, flow of information among stages reduction of transaction costs, price setting, selection of market channels, and the estimated profit margin. An analysis of the network will contribute to a comprehensive

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knowledge of the product progress across the value chain. It will also further help to understand how value appreciation/depreciation happens at any given stage.

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