SCAP
SOCIEDADE DE CIÊNCIAS AGRÁRIAS DE PORTUGAL

Challenges and opportunities for food processing to promote consumption of pulses

Desafios e oportunidades para o processamento de alimentos promover o consumo de leguminosas-grão

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http://dx.doi.org/10.19084/RCA16117

Received/recebido: 2016.08.31
Received in revised form/recebido em versão revista: 2016.11.24
Accepted/aceite: 2016.12.07

A B S T R A C T

The benefits that pulses bring to the consumers - nutritional, health and environmental - meet several of the current consumption trends in the EU. The evolution of pulses' consumption in the European regions displays two different panoramas: the North-South disparity and the similar lower consumption in the Eastern and Western regions. To improve consumer acceptance it is crucial to invest on educating and communicating to the consumers how pulses can contribute to healthy and sustainable diets. Here we present different food processing technologies that have the potential to increase not only the nutritional and organoleptic quality of pulses, but also it´s convenience of use as this emerges as a growing factor in the decision to purchase and food choice of consumers. This approach also includes the culinary innovation for the development of appealing, convenient and nutritive meals with healthy and environmental claims.

Keywords: Pulses, Consumption, Healthy Diet, Convenience

R E S U M O

Os benefícios – nutricionais, de saúde e ambientais - das leguminosas-grão vão ao encontro das atuais preocupações dos consumidores europeus. A evolução do consumo das leguminosas-grão nas regiões europeias evidencia duas situações diferentes: a disparidade Norte-Sul e o baixo consumo nas regiões de Leste e Oeste. Para melhorar a aceitação do consumidor é crucial investir na comunicação e educação alertando para os benefícios das leguminosas-grão para dietas saudáveis e sustentáveis. Diferentes tecnologias de processamento de alimentos são apresentadas com potencial para aumentar não só a qualidade nutricional e organolética das leguminosas, mas também aumentar a sua conveniência, já que este é um aspeto que emerge como um fator importante na decisão de compra e escolha de alimentos. A abordagem contempla ainda a inovação culinária para o desenvolvimento de refeições apelativas, convenientes e com alegações saudáveis e ambientais.

Palavras-Chave: Leguminosas-grão, Consumo, Dieta Saudável, Conveniência

INTRODUCTION

Pulses play an important role in the nutritional security of a large number of people, representing a major source of protein in many developing countries and being traditionally present in their dietary patterns. In the industrialized countries, pulses are becoming gradually viewed as an alternative source of protein and the base for flours, starches, and fiber ingredients.

Pulse meals are a traditional component of the food culture in Latin American, East Indian, and Middle Eastern countries. In Europe these grains are associated with rural heritage and also ethnic foods, reflecting the image of consumers localized or originating from Southern countries. Beyond this perception of a "Food from the Past", pulses hold a substantial potential for feeding future generations.

The consumption of pulses per capita has tended to fall over the past five decades. This decrease was more pronounced in Eastern and Southern Asia. In these regions, animal products have in part, substituted pulses as people increased their standard of living (Keats and Wiggins, 2014).

In spite of the recognized importance of such plants as a protein source, pulses face several limitations both in terms of appropriated processing technology and of consumer acceptability. Consumers tend to look for food supplies "ready to eat" these days however, innovation in pulse-based foods is still slowly rising (The Anderson Center, 2015). Additionally, consumer's acceptance of food is characterized by contradictory situations: modernity or degraded image, diet product or undigested food, appreciated flavor and texture but unfavorable appearance. The arguments for grain legumes are hence offset by several barriers limiting their consumption (Champ *et al*., 2015).

To increase consumer's acceptance of pulses these grains should be processed according to the European consumption evolution and trends, exploring their environmental and health benefits potential while improving the taste and convenience of these products. The aim of this review is to give an insight to these several issues.

EUROPEAN CONSUMPTION AND TRENDS

Even though the human consumption of pulses in Europe and the EU is lower than in other regions of the world, there is a lot of variation within Europe. Consumption of pulses varies greatly among the different European countries due to different regional food habits and traditions, and due to differences in production and supplies (Schneider, 2002). When the Common Agricultural Policy (CAP) was conceived, grain legume crops that were used exclusively for human consumption (chickpea, cowpea, groundnut, lentil, and common bean) dominated grain legume cropping in Europe with 67% of the area. This values dropped to 22% by 2010 (European Parliament, 2013). Today, only 57% of the food pulses consumed in Europe are produced within the EU (FAOSTAT, 2015). The market for pulses in Europe (especially Northern and Western EU) is underdeveloped compared to worldwide trade (CBI, 2015).

The evolution of the quantity of pulses consumed per year per capita in the four different European regions displays two different situations: the North-South disparity and the similar lower consumption

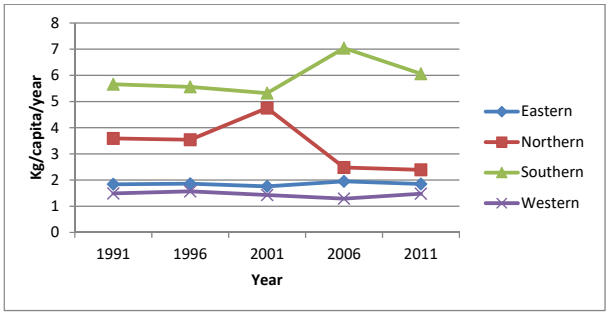

Figure 1 - Evolution of pulses consumption *per capita* in European regions.

in the Eastern and Western regions (Figure 1).

Since 2006, the Northern consumption has declined to values closed to the Eastern-Western consumption. In 2011, a Southern European consumer had a yearly consumption of 6.1 kg, a Northern of 2.4 kg and the Eastern and Western Europeans consumers had, respectively, 1.8 and 1.5 kg (FAOSTAT, 2015). Food habits, consumers' categories (age and social class) traditions and markets are the main factors associated to this diversity of consumption. Dried peas *(Pisum sativum)* and dried beans[1] are the most commonly consumed pulses in Europe, but the preference between species varies according to the country (CBI, 2015).

The "Mediterranean diet" that characterizes the consumption habits of the European Mediterranean countries (Italy, Spain, France, Greece and Portugal) is responsible for the majority of human pulse consumption in Europe. One of the ten

[1]Urad and mung beans, adzuki beans, kidney beans and other *Phaseolus* and *Vigna* beans.

principles of this diet is the higher consumption of plant products, including vegetables, fruit, bread, little refined cereals, dried and fresh legumes, nuts and oilseeds.

Figure 2 shows the evolution of the quantity of pulses consumption in five Mediterranean countries (FAOSTAT, 2015). It shows a decrease of consumption in all countries in the last five

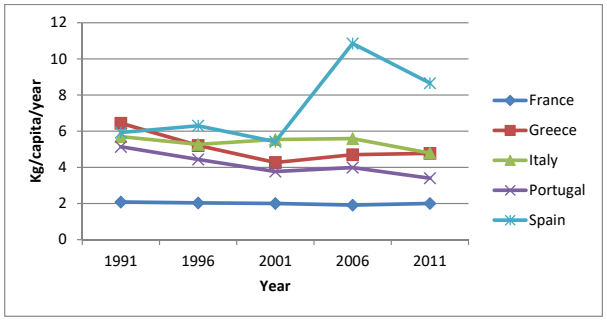

Figure 1 - Evolution of pulses consumption *per capita* in Mediterranean European Countries.

years, with Spain maintaining its position as the principal consumer (8.6 kg/per capita, in 2011).

Another interesting difference between North-European and South-European food habits is that Southern consumers prefer their local dishes and are in general less open to adopting Western food trends, compared to Northern Europeans. Also, South Europeans spend more time shopping for and preparing food. In contrast, Northern Europeans give more importance to convenience food products (Schneider, 2002). Therefore, pulses are increasingly sold in canned or frozen forms in northwest Europe, while dried pulses are still popular in the southern European countries (CBI, 2015).

Several works (Schneider, 2002; European Parliament, 2013; CBI, 2015; The Andersons Center, 2015) consider that the tendency in consumption of pulses in the European food market can change, because the pulses' benefits for consumers - nutritional, health and environmental - meet several of the current trends and demands of EU consumers and EU society in general.

In Nielsen's 2015 Global Health & Wellness Survey, when respondents were questioned about their nutritional needs, they considered very important foods that are high in fiber (36%), and about three in 10 look for foods that are high in protein (32%), have whole grain (30%) or are fortified with calcium (30%), vitamins (30%) or minerals (29%). When regarding to the importance of health attributes in purchase decisions for different age groups, it appears this attribute ratings is highest among *Millennials* (21-34), followed by *Baby Boomers* (50-64) (Nielsen, 2015). Targeting *Millennials* will be a great opportunity for food industry because this age group is behind the today "protein fever" (Kottke, 2016) looking for attributes like convenience, nutrition and natural.

To improve the interest of consumers about such "novel" yet traditional home grown food, different authors (Keats and Wiggins, 2014; Champ *et al*., 2015; Nielsen, 2015, The Anderson Center, 2015) argue that it is necessary to develop a concerted dialogue with consumers, providing them with information about the tastiness and health benefits of eating pulses. There is an evident unawareness of the protein content of pulses when compared to foods of animal origin and an advantage to taste perception that is attributed better to animal proteins.

To manage the current food trends identified above it is crucial to invest on communication and education of consumers, which should be, carried out by both public authorities and by different actors of the value chains (Champ *et al*., 2014). Consumers will make informed decisions if manufacturers and retailers help them understand the benefits of particular ingredients and foods using both out-of-store and in-store communications and package claims. Also, Chardigny and Walrand (2016) argue that, in Europe, the information transmitted at school and textbooks about the place of different food products in the food pyramid must identify pulses as a protein vector compared with the trilogy "meat-eggs-fish" as already considered in North America, particular in Canada.

For more than one decade ago The Health Organizations have simplified their communication to the consumer, promoting the regular consumption of pulses with the message "eat more plant-based foods". They encourage the consumption of pulses with a positive campaign, based on the traditional cuisine rather than on nutritional information. This long-term education

programme will probably have a better impact on people (Leterme, 2002).

Pulses can be expected to become new trendy food alternatives if their benefits are promoted and if the food industry and professional organizations integrate these grains in novel, convenient and healthy food products. Importers and food processors recognize the nutritional value of pulses, expecting them to become more popular as ingredients. Nevertheless they consider the main factors limiting their consumption in the EU to be: an inadequate level of innovation for developing products adapted to modern life, competition from cheaper low-quality imports and a small national supply of pulses (Schneider, 2002).

To create opportunities for new pulses based-food and growth in existing marketplaces, a continued work focusing on retaining or improving flavor, consistency of texture and color traits remains necessary. To increase the status and consumer acceptance of such foods, changes are also required at many levels of the society (Hallstrom, 2011).

EXPLORING ENVIRONMENTAL AND HEALTH BENEFITS

Pulses are known to be adaptable to adverse environmental conditions as they can grow in semi-arid regions for example, being highly resistant to disease and pests. They also have an important role in cropping systems due to the fixation of atmospheric nitrogen and to the increase of the overall soil fertility, which consequently contributes for reducing the need for nitrogenized fertilizers (FAO, 1994).

The replacement of diets with high environmental burden by those rich in pulses promotes a reduction of the environmental impact, which is actually an interesting sustainable option. A high interest in ecological welfare with respect for foods would be a strong driver to increase consumption of pulses (Hoek *et al*., 2011). Pulses can contribute to a more "sustainable extensification" of consumption and to a more "sustainable intensification" of production (The Andersons Center, 2015). Consumers that value sustainable farming systems (organic, traditional and low-input systems) will understand and add value to the role that pulses play in these types of agricultural systems.

Addressing potential health benefits for the consumption of pulses, the nutrients content of these grains must be highlighted. Pulses contain approximately 55–65% of their total weight as carbohydrates, mainly starches (FAO, 1994). The protein content of pulses ranges from about 20% (dry weight) in peas and beans to 38–40% in lupin (Duranti, 2006). A serving of pulses (half cup of cooked dried pulses) contains 2–4 g of fiber and 7–8 g of protein. Most pulses and their derivatives (flours) are very low in fat, generally containing 1-4% (FAO, 1994), and provide good quality protein, fiber and dietary-resistant starch (Holliday *et al*., 2011). Pulses also contain considerable amounts of B-vitamins and important minerals for human health, such as iron, calcium, and potassium, as well as phytochemicals: bioactive compounds, including enzyme inhibitors, lectins, oligosaccharides, and phenolic compounds (Rebello *et al*., 2014).

With the increase of consumers looking for foods that provide health and wellness benefits and contain ingredients that address illness mitigation (having functional properties), pulses fit in that category and therefore are very important as part of a healthy diet that adds protein and fiber. In fact, people are looking for foods that provide benefits that can either diminish their risk of disease and/or promote good health.

IMPROVING TASTE AND CONVENIENCE

Processing technologies

Pulses, due to their hard texture, are generally consumed after various processes like soaking, cooking, milling, roasting, puffing, and germinating. However, soaking followed by cooking is the most common way of consuming edible pulses and to ensure acceptable sensory quality. During these operations, the seeds undergo important chemical changes resulting in a much softer texture. Soaking is carried out below the gelatinization temperature and is intended for increasing the water content to accelerate the following cooking step as well as partially leaching anti-nutrient compounds (Fabbri & Crosbi, 2016), however, this process can also lead to potential loss of antioxidant components. Soaking treatments with 50%, 70%, and 85% hydration rates and short soaking times alleviate the losses incurred (Xu and Chang, 2008).

Cooking is done above the starch gelatinization temperature for gelatinizing and to produce a tender edible product, to develop aroma and to improve the overall acceptability of the pulses (Güzel & Sayar, 2012). Cooking softens the pulses and, in addition, inactivates or destroys substances present in the seeds that may cause digestive problems (Quinteros *et al*., 2003) by reducing the levels of heat-labile anti-nutrient components (such as lectins and trypsin inhibitors) and some complex sugars of the raffinose family (Aguilera *et al*., 2009). These oligosaccharides if not broken down by enzymes in the digestive system, can result in gastric issues such as gas production and flatulence (America's Test Kitchen and Crosby, 2012).

Cooking quality is measured in terms of increased firmness of the canned beans and a significantly decreased percentage of splits (Taiwo *et al*., 1997). Preferences may vary between consumers, as some may prefer split and mushy beans while others may prefer non-split beans (Mkanda *et al*., 2007). Based on sensory evaluation, samples with an average firmness between 12.5 and 22.5 N could be assumed to have the best sensory attributes (Ghasemlou *et al*., 2013). Cooking with salt addition can result in a tender skin due to sodium ions replacing calcium and magnesium ions bound to pectin in the cell walls (Wang *et al*., 1988).

The color and appearance, ease of preparation, wholesomeness of the grains and digestibility are other culinary characteristics important to consumers. The colors of beans and peas are determined mainly by anthocyanin pigments in the seed coat. Solid reds and blacks generally survive cooking, while mottled patterns become washed out when the water-soluble pigments leak into adjacent nonpigmented areas and into the cooking water. The intensity of color is best maintained by minimizing the amount of cooking water. Persistently green peas and dried beans owe their color to chlorophyll (McGee, 2004).

Enhancing the appearance and flavor of pulses through preparation and cooking can increase the consumption of these healthy foods, especially among children (Poelman *et al*., 2013).

Traditional cooking

The main conventional cooking methods of dried or soaked pulse seeds are boiling in water for an extended period of 1–2 h in an open pan or for 10–15 min under pressure (Anzalduá-Morales *et al*., 1996; Güzel & Sayar, 2012).

Whole dried beans and peas can take an hour or two to cook and this is due in part to their size, but also to the effectiveness of their seed coat at controlling the absorption of water, which is necessary for softening the cell walls and starch. Initially water can enter only through the hilum. After 30–60 minutes in cool water (more quickly in hot), the seed coat becomes fully hydrated and expands. From this point on, most of the water flowing into the bean passes across the entire seed coat surface, but the rate of flow is still limited. Pulses whose hulls have been removed - split peas, many Indian dals - cook more quickly and disintegrate into a mush (McGee, 2004). Regarding lentils and as mentioned, split peas, they have relatively short cooking times, and they do not require advance soaking (Polak *et al*., 2015) which is related to their smaller size and flat shape (Brown, 2011). Hardness after cooking is variable according to the pulse genotype (Saha *et al*., 2009) which also influences the overall culinary quality, together with conditions during production, and storage environment. Processors, while restricted by the expectations of consumers, seek properties that are related to cookability and a more efficient means of product preparation (Hosfield *et al*., 1984).

Pressure and microwave cooking

Apart from traditional cooking, pressure boiling and microwave cooking can also be used.

It was reported by Khatoon and Prakash (2006a) that pressure-cooking required much less time for cooking than did microwave cooking after germination of bengal gram, green gram and horse gram. Weight of pressure-cooked legume was higher than that of microwave cooking due to hardening (Khatoon and Prakash, 2006a). The increased moisture loss in microwaving was reported which could be due to a greater rise in post-oven temperature, which causes more dehydration through evaporation and increased shrinkage (Cross and Fung, 1982). Red gram and Bengal gram required 40 and 45 min of soaking time, respectively, for microwave and pressure cooking, while lentil and green gram required 15

min of soaking for pressure cooking and 30 min for microwave cooking (Khatoon and Prakash, 2006a). The microwave-cooked lentils were preferred and ranked superior, however, microwave-cooked Bengal gram was less desirable than the pressure-cooked sample (Khatoon and Prakash, 2006a). The sensory attribute of the microwave-cooked dhals depended on the type of dhals being cooked, but for most of the attributes, the results were comparable to conventionally cooked samples (Khaaton and Prakash, 2006b).

Sprouting and radiation

As any whole grain, pulses can also be sprouted (germinated) into fresh greens. Germination has been identified as an inexpensive and effective technology for improving the quality of pulses (Jaya and Ventkataraman, 1980; Chang and Harrold, 1988). It causes important changes in the biochemical, nutritional and sensory characteristics of pulses as it releases enzymes such as alpha-amylase that break down the starches into more readily digestible sugars (Brown, 2011; Polak *et al*., 2015), leading to a decreased flatulence caused by oligosaccharides while increasing the levels of reducing sugars. The process of sprouting also enhances flavor, nutrient content and palatability (Vidal-Valverde *et al*., 2002). Jodd *et al.* (1986) had earlier observed that 24 h germination was sufficient to eliminate flatulence-producing factors without causing loss of total available carbohydrates. In mung beans, horse beans, Bengal gram and horse gram, the reducing sugars increased sharply after overnight soaking and accounted for 40–50% of the total sugars after 2 days of germination with the reduction in raffinose family oligosaccharides from 50–60% in dried seeds to less than 10% on the 4th day of germination.

Sprouts from radiation-processed legumes, as such or in powder form, either alone or in combination with cereal flours, could be used to prepare easily digestible weaning and healthy foods with lower flatulence factors (Machaiah and Pednekar, 2002). Radiation treatment does not affect the acceptability of these pulses in terms of sensory attributes, such as taste, aroma, texture and cooking quality, unlike other procedures used for reduction of flatulence factors (Calloway *et al*., 1971). Radiation-processed pulses, such as horse beans and Bengal gram, exhibiting reduction in flatulence factors in the dried state, as well as providing good quality proteins at lower cost, would be more acceptable when incorporated into cereal-based snack items (Machaiah and Pednekar, 2002).

Extrusion

Among the various pulses' processing techniques, extrusion has been used for processing many of these grains and offers the advantage of high productivity, shorter cooking times, energy efficiency, and relatively lower operating costs (Balandran-Quintana *et al*., 1998; Rocha-Guzmán *et al*., 2006). Extrusion has also been shown to be the most effective method for improving protein and starch digestibility when compared with dehulling, soaking and germination (Alonso *et al*., 2000; Batista *et al*., 2010) and lowers flatulence-causing oligosaccharides (Borejszo and Khan, 1992). Extruded navy and pinto beans showed that a high temperature (>100 °C) process may produce undesirable functional and sensory properties in bean flours (Nyombaire *et al*., 2007). Literature focusing on the effects of process variables on the functional properties of extruded beans is scarce as most of the extrusion processing technology applications is seen in the development of cereal and soybean based products. However, the gluten-free and high-protein content of dried beans and pulses offers opportunities for the application of extrusion to the development of bean-based products. Flours from dried beans have the potential to extend bean consumption beyond traditional uses.

PROTEIN ISOLATES

The interest in plant based protein isolates is growing in the food industry, not only because of dietary restrictions and consumers' preferences (related allergies, vegetarianism, Halal requirements, etc.) but also for their particular properties and low cost (Carbonaro *et al*., 2014; Shevkani *et al*., 2015). Pulses, as a great source of protein, are used to make that kind of isolates.

Although soy beans are the main resource for plant protein isolates, pulses, such as peas or faba beans are now gaining space on that market (Chereau *et al*., 2016). Pea protein is an example of pulse that can compete with soy bean on those terms: pea

protein is easy to extract due to its low fat content, simplifying the process of extraction, and having a good emulsifying and foaming properties (Bramsnaes and Olsen, 1979; Karaca *et al*., 2011). Faba beans, also have properties as emulsifier, and it's a cheaper pulse (Karaca *et al*., 2011).

Protein isolates have different properties depending on its source as evidenced by Shevkani *et al.* (2015). These authors compared kidney bean and field pea proteins for their functional properties: kidney bean protein may be appropriate for products that require strong gel formation (fish and meat products, curds, gels, etc); field pea protein, on the other hand, may be more suitable for breads, cakes, muffins and for cold meat products, for their water binding properties.

CULINARY INNOVATION FOR CONVENIENCE

Pulses are very interesting for the versatility of use and therefore have been studied as ingredients in scientific research for several years in order to develop products with unique functional properties as well as enhanced nutritional profiles which can have a home and restaurant application and also industry scale up possibilities: they can be main ingredients or just an add on different meal times (breakfast; brunch, dips, salads, side dishes or mains); used as meat substitutes; used in specific kind of diets (gluten free, vegans); are interesting fat replacers and emulsifiers and their flours are suitable for gluten free formulas. Due to these characteristics, pulses can be an alternative to soy when it comes to reduce fat and meat content in ground meat products, for example. Just to mention some of the research, according to a study by Holliday *et al.* (2011) involving 23 types of pulses to assess their potential as meat replacers in meat patties, it was determined that by using specific species at the correct ratio to meat, a meat and analog hybrid can successfully be developed to meet the needs of today's consumers (health, appearance, juiciness, and tenderness). Incorporating pulses, the overall nutritional profile can be improved by reducing calories, total fat, saturated fat, and cholesterol and increasing fiber. The functional properties of pigeon pea (*Cajanus rajan* (L) Mill) protein concentrate, such as protein solubility in relation to pH, water and oil absorption capacity, gel formation ability and stability of emulsions, indicate that there are possibilities of using this in formulation of meat products, meat substitutes, sauces and soups. Also the ability to form good and stable foams raises the potential application of this product in bakery products and confectionery (Mizubuti *et al*., 2000). Studies on other pulses protein extracts applications are very promising as mentioned before (Shevkani *et al*., 2015; Chereau *et al*., 2016) specially when considering protein as one of the key ingredients consumers are looking for. This makes for certain an opportunity for the food industry to modify foods in a protein paradigm (Package Facts, 2016) as well as for caterers.

Pulse flours and their protein extracts can contribute significantly for protein fortification of products and dishes to align them with the protein diet trend. Flours for wheat free products or as partially wheat flour replacers can be used alone or together with other gluten free flours such as rice, tapioca or potato flours. Pre-cooked or legume flours are finding a way into a wide variety of products to fortify fiber and protein and improve texture. Some examples can be addressed, such as the mung bean flour used as stuffing in various dessert products (APO, 2003). In gluten free breads, formulations containing 20% corn flour and 80% chickpea flour had the greatest effect on improving quality (Rostamian *et al*., 2014). Results also showed that substituting wheat flour with chickpea flour at level of 10 to > 20 % produced dough with better properties almost similar to the wheat flour dough (Mohammed *et al*., 2014). Bean flours are also being made and used in grain products, such as tortillas. Up to 25% of wheat flour in tortillas can be replaced with bean flours, which yield a tortilla with similar texture, appearance and flavor while improving the overall nutrient profile (Anton *et al*., 2008), the same results were obtained when supplementing flat bread with up to 15% of bean flour (Seleem & Omran, 2014). There is already pulses-flour pasta suitable for gluten free diets keeping all the *al dente* texture as the traditional Italian pasta (Cassi, 2011); some pasta brands rely on pulses bestowing it with twice the fiber and more than 40% more protein than traditional pasta (NPGA, 2016) and more possibilities arise in terms of formulas using different species, including at the restaurant level, where specially fresh pastas can make a difference.

Other studies have also shown that pureed beans can be used to replace up to 50% of the fat in brownie recipes and still yield an acceptable end product (Szafranski *et al*., 2005). Further research indicated

that formulation of low-fat beef burgers containing 6% micronize gluten-free binder made from lentil and chickpea flour was possible based on favorable results for physicochemical properties and consumer acceptability (Shariati-Ievari *et al*., 2016). Starch is another consideration when adding pulses. Pea starch isolates are distinctive for their gel strength quality and bland taste. Such features, along with the ability to contribute to increased volume and expansion in extruded products and puffed snacks, make pea flour perfect for inclusion in cookie and cracker formulations as well as Asian-style noodles (WDPLC, 2009). Pea starch isolate can also be used in place of modified cornstarch or low-fat gums. Pea starch is so proficient at binding water that it increases viscosity and promotes the smaller ice crystals associated with higher fat ice creams (NPGA, 2016).

Apart from the substitutions prospective, innovation with pulses can also happen in traditional foods by diverse ways: portion sizes, converting traditional foods into snack food, suited for the grab and go trend (incorporation pulses in filling of sandwiches, wraps or as ingredients of edible containers); the production of artisanal or industrial nutrition/power/energy bars and quick cooking preparations based on pulses (Sethi *et al*., 2014).

It is known that traditional gastronomy is a privileged way of promoting the valorization of local quality agrifood products (Cristóvão *et al*., 2008), but also working on the presentation of traditional dishes based on pulses is a great possibility for innovation at the restaurant level. Working with the colors and shapes of pulses incorporated in traditional dishes increases the Chef's possibilities to enhance dishes appeal. Des-construction and re-construction of traditional recipes re-interpreted by the Chef increases the interest of consumers/clients. Additionally, this culinary innovation approach in foodservice may include meal solutions for experiences of restaurant-quality foods with little or no preparation with added health benefits: as previously mentioned, grab-and-go segment is seen as a great opportunity to increase sales across all meal occasions (Packaged Facts, 2016); moving pulses protein to the center of the plate; marketing innovation in terms of label emphasizing protein content of pulses based dishes, meals and beverages, turning easy and quick for customers looking for high-protein option – are innovations possibilities seen in the sector. The availability of "ready-to-eat" cooked pulses favours the increase in the at-home intake and adapting it to current lifestyles because the traditional methods of preparation are generally labour-intensive and time-consuming (Pedrosa *et al*., 2014). One example is the development of sauces, fillings or dips based on pulses– vegetarian spreads and sauces emphasized in the proliferation of humus recipes; fillings for deserts or for salty preparations like patties, all ready-to-eat which are very convenient products both for home use and caterers', as little or no preparation is required prior to use.

Finally, another possibility for culinary innovation tailored to the present way of life is consumer-packaged food targeting a diverse audience: one or various categories of people such as children, athletes, millennials, women, and elderly. Such ready to eat meals and dry food preparations, can have different line extensions according to the target consumers, with different textures, shapes, nutritional values, just to mention a few. The same applies to many other food categories, like snacks, breads and pastry.

CONCLUSIONS

At the moment pulses are highlighted as a food trend in spite of their ancestral and current traditional culinary use. However, consumers remain largely uninformed of the environmental and health benefits of including pulses within their diets.

To improve the consumer acceptance it is crucial to invest on communication and education of environmental and health benefits which should be carried out by both public and private agents.

Together with the environmental, health and organoleptic issues, the easiness and quickness of use continues to be one of the factors that weights the most in purchasing decisions and food choices. Therefore, apart from the high potential for developing new, tasty, environmental friendly and healthy products from pulses, the intersection with convenience is extremely important to consider when thinking about culinary innovation.

ACKNOWLEDGEMENTS

The research leading to these results has received funding from the European Community's Seventh Framework Programme (FP7/2007-2013) under the grant agreement nº FP7-613551, LEGATO project.

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