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Potential innovations for the traditional durum wheat food sector

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ABSTRACT

As a cereal and staple food of our diet, durum wheat is largely consumed worldwide through a large variety of food products (pasta, couscous, bulgur, etc.). From all cereals, durum wheat-based products are playing a crucial role in culturally-diverse healthy Mediterranean diets and in the maintenance of employment in the Mediterranean basin, especially for small and medium enterprises (SMEs) and family owned businesses. Here, traditional food recipes based on durum wheat and traditional production methods are widely practiced, however, facing heavy competition with industrial produced durum wheat products and other cereal-based products. This work presents a prospective analysis of potential innovations in the durum wheat sector, particularly regarding the traditional products and various associated manufacturing processes in the Mediterranean area. Today, the development of competitive, energy saving and environmentally friendly production systems are imperative; therefore, innovations are identified and analyzed regarding all three dimensions of sustainability (economic, social and environmental). In addition, it is shown that challenges for SMEs of the durum wheat sector are related to the ability to keep typicality in safe and sustainable food products and to reconcile tradition and modernity while taking into account economic, sociological, regulatory and environmental changes. As support is needed to help SMEs and traditional food producers to develop in this direction, several policy recommendations are proposed.

Keywords: Durum wheat ; Innovations ; Traditional food ; SMEs

INTRODUCTION

Cereal products based on wheat, rice, barley, maize, rye, oats, millet, sorghum, etc. are staple food of our diet. Among them, durum wheat (*Triticum turgidum* subsp., *durum* Desf.) has the specific feature of being 100% dedicated for the food market. Durum wheat properties make it an excellent resource for pastas, couscous, a variety of breads, biscuits, and pancakes (Abecassis et al., 2012). These durum wheat-based products are playing a crucial role in maintaining employment in the Mediterranean Basin, especially for small and medium-sized enterprises and family owned businesses. In Maghreb and other Mediterranean countries, traditional durum wheat-based food and traditional production methods are widely present, however, heavily competing with industrially produced durum wheat products. In the future the traditional recipes and practices may disappear if strategies aren't developed to maintain cultural and culinary heritages. Hence, innovations are required for the durum wheat chain both in the food as well as in the non-food domain, like for other cereals. Innovations help (1) to provide a more attractive offer of traditional products fulfilling consumers' expectations, e.g. through product variations and new convenience products, (2) to increase the competitiveness and economic profit of traditional food producers, e.g. through organizational innovations and new low-cost-high-value local production schemes, and (3) to make sustainable development a business reality, e.g. through eco-conception and added value of wheat straw and other co- and by-products. This paper provides an overview of the traditional durum wheat-based products as well as a prospective analysis of the potential innovations in the durum wheat sector, particularly regarding the traditional products and associated manufacturing processes in the Mediterranean area. It is then discussed why those innovations are more beneficial for SMEs than for large scale producers, taking into consideration risks and boundary conditions. Finally, policy recommendations for an action plan are proposed to create the conditions and tools for the implementation of sustainable solutions required to enhance growth and competitiveness of small businesses and encourage entrepreneurship.

1. A variety of traditional durum wheat-based products in the Mediterranean basin

Some authors have made either a global inventory of traditional and/or innovative products based on durum wheat (Elias, 1995 ; Faridi and Faubion, 1995 ; Abecassis et al., 2012) or a national one (Kezih et al.,

2014). On the basis of these inventories and publications, a classification based on the complexity of processing allows to identify three main categories of durum wheat-based food products: (1) Products consumed in the form of grains (whole grains or coarse-ground grains), (2) Products prepared by agglomeration of semolina (associated with the maintenance of granular structure), and (3) Products made by formation of a dough (continuous medium), obtained by addition of water to semolina, remilled semolina and/or durum wheat flour.

Pasta and couscous are the most common durum wheat-based products. Pasta refers to the Italian national dish and is the most consumed durum wheat-based food product. In addition to big pasta manufacturers, pasta is still prepared by family owned businesses and SMEs. A lot of scientific literature focuses on pasta processing, which consists of three main unit operations (hydration and mixing of semolina, shaping through extrusion and drying), and its quality determinants (Sissons et al., 2012). Over the last decades, pasta quality has benefited from several improvements of technology and equipment (e.g. for pasta drying). However, new challenges involving energy usage reduction and improvement of pasta nutritional properties are arising. Couscous was invented in North Africa by the Berbers and is there still highly consumed. Couscous grains are prepared at artisanal, semi-industrial and industrial scales. Only few scientific studies investigate the couscous processing which involves three main stages (wet agglomeration of semolina, steam cooking and drying). This has restricted potential innovations of the process (Abecassis et al., 2012). However, in some European countries within the Mediterranean basin, couscous is becoming more popular thanks to its versatility and convenience, to new consumption patterns towards “ethnic foods”, and to the increase in the Arab population in Europe (D’Egidio and Pagani, 2010). In addition to the traditional couscous dish, new couscous products are launched and marketed as convenient and easy-to-cook full meals (main dish, salad, etc.) in line with present consumer’s expectations (Minister of Agriculture and Agri-Food Canada, 2013). Couscous becomes thus a modern and trendy food, not only dedicated to specific ethnic groups. Besides pasta and couscous, a description of other traditional durum wheat-based food products is presented in Table 1.

Table 1. Description of some traditional durum wheat-based food products

Product	Short description	Raw materials	Main processing steps	Production scale(s)
Bulgur	<ul style="list-style-type: none"> - Staple food in Turkey and the Near East - Long shelf life, low cost, good source of dietary fiber and protein, low glycemic index¹ 	Mature durum wheat grains	Cooking, drying, partial dehulling and crushing	Artisanal & industrial
Frekeh (frik or firik)	<ul style="list-style-type: none"> - Produced in farms and villages in North Africa and the Middle East² - Substitute for rice and <i>bulgur</i> in pilav - Potential nutritional quality of immature grain 	Immature (early harvested) durum wheat grains	Drying, roasting and crushing	
Pastries, Desserts	<ul style="list-style-type: none"> - Pancakes, layer cakes and couscous - Consumed during traditional celebrations or religious events in North Africa and Middle East - High contents of fat and sugar³ 	Durum wheat flour, semolina and other ingredients	Kneading, shaping or sheeting, cooking (in oven or on a plate)	Artisanal (mainly)
Breads	<ul style="list-style-type: none"> - Western-style and Oriental-type breads³ - Leavened or unleavened paste; flat or not - Peculiar taste and smell, longer shelf life than common wheat breads 	(water, fermentation agent, sugar...)	Kneading, fermentation, shaping or sheeting, cooking	
Kishk	<ul style="list-style-type: none"> - Traditionally prepared for domestic consumption in North Africa & the Middle East - Used to make soup, yoghurt or sauce - Higher content of B vitamins than either wheat or milk⁴ 	<i>Bulgur</i> and strained yoghurt	Lactic fermentation, drying, grinding into fine powder	Artisanal

¹Yildirim et al. (2008) ; ²Özkaya et al. (1998); ³Abecassis et al. (2012) ; ⁴Blandino et al. (2003)

As demonstrated, there is a wide diversity of durum wheat-based products, either industrially produced for national and international mass markets or manually prepared for niche markets in a restricted geographical area. The production and consumption of durum wheat is highly regionalized in the traditional area, namely the Mediterranean basin, which concentrates about 60% of the world durum production and almost two third of the worldwide durum consumption (Sissons et al., 2012). Quality criteria of durum

wheat-based food products continually evolve in response to market pressure and consumer preferences but also to technological advances in durum wheat milling and semolina processing (Dexter and Marchylo, 2000). Over the last decade, citizen and society expectations have led to more attention for sustainability, traceability, nutrition and health (Flagella, 2006). Novel processes and technologies have allowed adapting end-product quality to expectations, while maintaining or even improving cost efficiency (through higher yields and/or productivity). Depending on the country and the concerned segment of the durum wheat value chain, SMEs are playing a key role next to large enterprises, both in terms of volumes and sales revenues. For instance, Algeria is the first country for couscous production with about 1 million tons per year (D'Egidio and Pagani, 2010), of which half is still artisanal (Lebeau, 2014). Further innovations concentrating on small-scale businesses and artisanal production would thus have major interest and impact. The knowledge of and the developments in the couscous and pasta chains permit to (1) further research potential innovations in these chains and (2) use the two products as reference for the other durum wheat based food products.

2. Potential innovations along the durum wheat value chain of traditional durum wheat foods

For small-scale businesses, we should consider a variety of novel developments that may give an impulse to competitive traditional food production and consumption. Several innovations in the technological and marketing domains are listed below. Such innovations could allow maintaining the specificities of traditional products while reducing costs and increasing the value and perception of these products.

2.1. Process-related innovations

Numerous processing systems are still at the handicraft level for traditional food production. Often this is highly interesting from a marketing point of view providing new differentiation options for dishes traditionally prepared. In other cases, improved processing systems may help in reducing costs, processing duration and spoilage, increasing safety, enhancing or maintaining nutritional value, etc. Emerging, sustainable technologies are popping up revealing diverse applications in different parts in the transformation scheme. In more detail, some potential technologies for traditional foods are listed below.

New fractionation & biorefinery systems - Some examples of innovative fractionation systems that better allow to maintain the nutritious health characteristics of grains (especially including bran) are (i) cracking combined with conventional milling to separate bran into functional ingredients, (ii) cryogenic milling which allow to obtain a ultrafine powder and reduce the grinding time with at least a factor three, and (iii) electrostatic separation which consists in preloading particles with a subsequent separation in an electrical field and is able to reach aleurone enriched fractions (Hemery et al., 2011). These processes open the way for new biorefinery concepts that focus on reaching functional fractions for numerous applications (Waldron, 2014) thus allowing to efficiently valorize co-products obtained from cereal processing. SMEs within the traditional food sector could benefit from these innovations either by selling co- and by-products from their milling unit to fractionation-dedicated processing firms or by using the obtained functional ingredients to enrich their traditional formulations with health compounds having better bioaccessibility. This could help SMEs to provide an attractive offer of high added value traditional products, taking into account consumers' expectations regarding healthy foods.

New processes for structuration and stabilization of food products – In general the technological principles of pasta drying are based on air temperature, moisture content and air velocity. Nonetheless new systems based on the application of hot steam and microwave as volumetric heating technology may have an interest for SMEs as it allows to improve the efficiency and economics of the drying process, while obtaining a final product without fissures (De Pilli et al., 2009). Another innovation is the pasta-legumes mixed products that may allow well-balanced protein diets in the future, revealing excellent protein profiles in sufficient quantities for a healthy diet (Petitot et al., 2010). Structuration of mixed pasta has already been studied and technically, mixed products can be produced even if texture needs to be improved. Nevertheless, co-processing of mixed products from the harvest to the end-product manufacturing is still a challenging task. Actually it has been shown that cereal-legume mixed crops allow reducing fertilizer input due to the excellent nitrogen fixation capacity of legume plants in symbiosis with nitrogen fixing bacteria. If

grains are not separated during or after harvest, challenges for agronomists and technologists are related to the ability to harvest two types of grains at the same time and to replace current milling by co-milling of grains having different size, density and hydration levels. Despite existing bottlenecks, co-processing of legumes and durum wheat could be an opportunity for traditional pasta makers and durum wheat processors to develop products with both higher nutritional value and lower environmental impact; thus market differentiation becomes feasible.

2.2. Marketing innovations

New labels and brands – Labels and brands are used as differentiation tools that are able to give competitive advantage by highlighting a specific quality attribute related to the place of origin (of production or processing), the process or the end product (Ilbery et al., 2005). New labels can be exploited to add value to traditional, healthy, sustainable or local durum wheat-based products. For several durum wheat-based food products, traditional and modern manufacturing methods are coexisting and conducted for classification of products. Being only indicative, this classification is not subordinate to regulations. A label which would certify the type of process (modern vs traditional) could help to distinguish traditional products from the industrial ones. Giving the increasing demand for healthy foods, further research on process-structure-function relationships could provide options for new nutritional claims for traditional small scale producers; however, European Food Law may hinder especially SMEs to prepare appropriate files. In addition, durum wheat recipes being part of the Mediterranean Diet - recently rewarded as Intangible Cultural Heritage of Humanity status as a model for healthy eating and associated lifestyle (UNESCO, 2010) – could be marketed via the creation of a Mediterranean, collective and territorial label for healthy diet. This reinforces a niche market positioning.

New short supply chains and market initiatives - The difficulty for the pasta industry to respond to increasing resource prices and to requirements of large retailers lead to a critical situation in particular for European SMEs (UNAFPA & Semouliers, 2007). Thus, exploring alternative and innovative distribution channels, such as short supply chain concepts, may be more beneficial than utilizing the large retail channels. In the case where major sales pass via the large retailers, collaborative tailor-made contractual solutions have to be developed between SMEs and retailers, often supported by policy measures, to encourage new marketing concepts in supermarkets (e.g. stand with Sud-de-France products promoted during one week). Self-regulation, new legislative measures and administrative burdens should be reconsidered that allow fair competition for SMEs with respect to large multinationals (De Vries and Gerbrandy, 2011). According to Banterle et al. (2009), SMEs characterized by flexibility and agility could shift the orientation of their strategies from the product to the marketplace in order to detect and profit from new market opportunities.

3. Discussions based on threats and opportunities for small-scale producers of traditional durum wheat-based products

A growing world population, changes in eating patterns, an increasing demand for meat products (with cereals as feedstock), some niche markets like organic or gluten-free products are among the major societal challenges likely to impact the traditional durum wheat sector. Next, more authentic, healthy, natural and traditional foods with simple and reassuring compositions are becoming more popular taking into account the product origin. In addition, the trends towards more convenience products may have positive impact due to value adding options for especially the cereal-component. Within this context, durum wheat products appear well suited to contemporary lifestyles. The consumers identify positive values in durum wheat-based products, which could be improved and valorized in both traditional (e.g. farm-produced pasta) and innovative products (e.g. precooked grains such as EBLY or GRINN's, mixed cereal-legume pastas) (Académie des Technologies, 2006).

The evolution of eating habits seems to open up new market sectors, hence new opportunities would potentially arise for SMEs within the durum wheat sector. One could ask under which conditions the above mentioned changes could reinforce SMEs competitiveness? We could pose the hypothesis that if market changes are faster than the way multinationals (with large volume, high throughput, standardized production methods and large investments) could adapt, than the SMEs could gain in competition, being

more flexible to launch product innovations. However, it is of primary importance that these enterprises pay attention to the monitoring and understanding of the societal challenges and the development of appropriate strategies (novel innovations, potential partners, SMEs-dedicated research and technology transfer programs, *etc.*) allowing them to support their development. Second, whether these transitions will be an opportunity or a threat for the future of small scale enterprises will depend on their capacity to integrate new expectations (coming from citizens, consumers, regulation authorities, professionals of the durum wheat sector, *etc.*) into the quality of traditional durum wheat-based products.

The tightening of environmental and sanitary regulations is another challenge for the durum wheat sector. In addition, the environmental changes (in terms of climate change and biodiversity) constitute a major threat for continuing the durum wheat cultivation in the traditional production areas. Thus, it encourages proposing agronomic, engineering, marketing and policy measures in order to foster the agro-ecological transition while maintaining a durum wheat quality which fulfills end-product manufacturer and consumers expectations. On the contrary, regulations could hinder SMEs in case the administrative burden increases and investments are lacking for appropriate R&D efforts. The challenge is thus to help traditional small-scale businesses to comply with regulations and make sustainable development a business reality.

Overall, economic, sociological, legal and environmental changes are likely to impact the traditional durum wheat food sector. Price fluctuations and local-global competitiveness are among the major economic changes. SMEs have to face economies of scale and competition with large firms and retailers. Local *versus* global competition requires on one hand new marketing strategies based on a differentiation by niche market positioning, by labelling and by innovative packaging and on the other hand low-cost-high-value local production schemes; the latter should preferentially focus on the overall valorization of end-products. This is even more important due to the rising growth of the price beating low-cost retail sector.

4. Conclusion

Here we have shown the rich diversity of traditional food products based on durum wheat as well as existing and potential innovations in the product, processing and marketing domains. Some of these innovations are not immediately transferable to SMEs. Research and development is still needed for most of the process innovations to improve efficiency and profitability. Moreover, it seems essential to make sure that innovations will be well accepted by consumers. As far as product and process innovations are concerned, incongruence can appear with traditional foods that will potentially not be considered traditional anymore (Stolzenbach et al., 2013). Challenges are then to keep typicality in safe and sustainable food products and to reconcile tradition and modernity while taking into account economic, sociological, regulatory and environmental changes. As support is needed to help SMEs and traditional food producers to develop in this direction, we propose the policy recommendations stated below.

5. Policy recommendations for an action plan

In order to encourage entrepreneurship and improve competitiveness of the traditional durum wheat sector in a more and more challenging environment, policy recommendations are proposed to create the conditions and tools for the implementation of sustainable solutions. The creation of a platform for the demonstration of novel technologies (including those presented above), also being the place for on-site advice and innovation transfer seminars, would ensure a transmission of research results to SMEs. It would allow getting feedback from SMEs on the research activities carried out in the field of durum wheat. Being aware that SMEs have limited time to spend out of the office, an online portal could also be set-up to provide information about innovations, following the framework of the online information shop of the FP7 European project TRAFoon (www.trafoon.org). Care is needed to keep the portal up to date over years requiring continuous investments. This could be achieved by integrating portals and seminars into the daily operations of existing SMEs associations. In addition, support in international marketing and sales have to be further developed for traditional durum wheat-based food products especially revealing the country of origin characteristics and the adherence to the Mediterranean Diet (UNESCO, 2010).

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