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Exploitation of Tartary buckwheat as sustainable ingredient for healthy foods production

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Abstract

Tartary buckwheat (*Fagopyrum tataricum* Gaertn) is a minor crop belonging to the *Polygonaceae* family that can be considered as sustainable crop thanks to its low input requirements. It is a pseudo-cereal known for its high healthy value related to antioxidant compounds present in its grains. For this reason it could be employed for the production of functional foods. This paper as well as reviewing about the agronomical and nutritional traits of buckwheat also provides the latest experimental results achieved by ENEA research activities.

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Keywords: sustainable agriculture; minor crops; Tartary buckwheat; antioxidant compounds; healthy foods

1. Introduction

Nowadays, the public opinion is particularly attentive to the so-called "green" topics. In this scenario, scientific research is required to make a significant contribution towards biodiversity and environmental safeguard, sustainable use of resources, peoples' health and wellbeing. To provide an answer to the above issues, an opportunity is offered by the use of underutilized minor crops.

Minor crops (buckwheat, oat, millet, rye, etc.) are grown in limited areas or produced in small quantities, and have the main limitation to wider utilization in their reduced grain yield potential. The development of improved

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cultural practices, together with the creation of more productive cultivars, can afford to increase the yield and the quality of these crops, allowing the full exploitation and use and offering to consumers the tools to take care of their health in a simple and cost-effective way.

The promotion of minor crops cultivation is in accordance with the commitments of sustainable agriculture emphasized in EASAC Policy Report (2011), as ensuring eco-efficient production, more nutritious and quality foods and minimizing land use and inputs. Furthermore, these crops may represent an economically sustainable mean for the biodiversity enhancement (Brunori et al., 2014).

Among minor crops, buckwheat (*Fagopyrum* spp.), a pseudo-cereal belonging to the *Polygonaceae* family, has received increasing interest.

Purpose of this paper is presenting a brief review about the agronomical and nutritional traits of buckwheat and showing research activities carried out by ENEA (Italian National Agency for New Technologies, Energy and Sustainable Economic Development) for the exploitation of Tartary buckwheat as a sustainable crop and potential ingredient for functional foods.

2. Buckwheat

Two buckwheat species are mainly used for human consumption:

- Common buckwheat (*F. esculentum* Moench) that is originated from Southwest China and cultivated in Russia, Japan, Canada, Europe. This species was historically cultivated in Italy on limited areas of the Alps and the Central and Northern Apennines. Gradually replaced by wheat and other cereal with higher yields, recently this crop has aroused new interest with respect to the possibility of using it for to the preservation of biodiversity and the recovery of marginal areas
- Tartary buckwheat (*F. tataricum* Gaertn) that grows and is used in the mountainous areas of Southwest China, Northern India, Bhutan, Nepal and also cultivated in limited regions of Slovenia, Italy and North Europe. This crop, comparing to common buckwheat, is less widespread due to its bitter taste even if it has more interesting nutritional profile

2.1. Agronomical traits

Buckwheat can be planted in various soil types, even infertile and poorly tilled lands, even if previous crops with beans improves buckwheat growth (Khan et al., 2005).

The use of this crop as a green manure can strengthen soil nutrients (Tsuzuki, 2001). In particular, buckwheat is a so-called “phosphorus scavenger” due to its high capability of take up soil phosphorus (P). In fact its roots exude compounds able to solubilise P presents in the soil and have high storage capacity for inorganic P, so when buckwheat plants are incorporated in the soil they make nutrients available to next crop (Valenzuela and Smith, 2002).

As a cover crop, it has a strong ability to suppress weeds (Xuan and Tsuzuki, 2004) due to its rapid growth, which results in rapid establishment of the canopy, competition for light, and interference with the growth of weeds (Oplinger et al., 1988). In detail, it has been noticed that Tartary buckwheat has a high allelopathic potential (Tsuzuki et al., 1975).

Furthermore common buckwheat is attractiveness to beneficial insects like natural enemies that suppress pests such as whiteflies, aphids and pollinators (Frank and Liburd, 2005). Flowering buckwheat provides a foods source for beneficial insects such as hover flies, predatory wasps, minute pirate bugs, insidious flower bugs, tachinid flies, and lady beetles. Buckwheat may also be grown in strips, windbreaks, or patches when used as an insectary crop (Valenzuela and Smith, 2002).

Tartary buckwheat is resistant to environmental conditions at high altitude (from 1,200 to more than 3,000 m a.s.l.) characterized by a thin soil layer, low temperature, minimal agricultural infrastructure (Lin et al., 2006). As such, it was a good replacement for common buckwheat, especially in the marginal growing areas.

2.2. Nutritional traits

Buckwheat grains are characterized by high nutritional value due to the high content of phenolic compounds (Kreft et al., 2003), biologically high-valued amino acids (Krkoskova and Mrazova, 2005), dietary fiber (Bonafaccia et al., 2003) and mineral (Ikeda and Yamashita, 1995), all bioactive compounds responsible to several healthy properties (Christa and Soral-Smietana, 2008).

This crop is characterized by high amounts of flavonoids, the most common phenolic compounds in plants but not synthesized by humans or animals (Cook and Samman, 1996). In particular buckwheat is a good source of rutin and quercetin (Jiang et al., 2007) which have shown many potentially health-beneficial effects in animal and *in vitro* test, as antihyperglycaemic activity, protective effects against the development of diabetes, mitigating antioxidant properties, anti-infiammatory activity, anti-platelet formation properties, a mitigating effect on cardiovascular diseases (Brunori et al., 2007). Few experimental dietary studies carried out on human show that the consumption of buckwheat products may have beneficial effects on reducing cholesterol and cardiovascular risks, nasal irritation and fatigue (Wieslander et al., 2011; 2012).

Tartary buckwheat is richer in rutin and quercetin than common buckwheat (Fabjan et al., 2003), so the introduction of its grain in the recipe of traditional foods products (for example, bakery products and pasta) could lead to innovative and potential functional foods (De Rossi et al., 2013).

3. Functional foods and health claim

Functional foods are a promising segment of the agribusiness, even if it still lacks an universally accepted definition for these products (Canavari et al, 2007). Generally they are defined as foods offering additional benefits that may reduce the risk of disease or promote optimal health. In the face of increased health care costs related also to a higher occurrence of pathologies correlated with poor eating habits, clinical and epidemiological studies show that a healthy and balanced diet, rich in fruits, vegetables, whole grains, fish and dairy products, to low in saturated fat and sodium, brings numerous benefits and can reduce the risk of diseases such as cardiovascular disease, hypertension and some types of cancer (Bellisle et al., 1998).

The introduction and exploitation of functional foods represents a great opportunity for the revaluation of traditional foods products as well as the development of novel ones rich in bioactive substances.

In order to ensure that any claim made on a foods label in the European Union is clear and substantiated by scientific evidence, in December 2006 has been adopted the Regulation 1924/2006 concerning the use of health claims: “any statement on labels, advertising or other marketing products that health benefits can result from consuming a given foods, for instance that a foods can help reinforce the body’s natural defences or enhance learning ability” (http://www.efsa.europa.eu/en/topics/topic/nutrition.htm).

EFSA (European Foods Safety Authority) must verify the scientific substantiation of the submitted claims and has prepared guidance on how to submit claims applications, following an extensive consultation process with industry and other interested parties.

Up to now, there aren’t approved health claims about buckwheat or molecules contained in its grain, although some attempts have been made. In proposal 1482 isn’t recognised the immune-system support of buckwheat extract containing flovonoid-mineral complex, and the beneficial effect of rutin and quercetin on human health hasn’t been yet demonstrated (proposal ID 1884, 1845, 1846, 1847, 1783, 1784). Nevertheless scientists will not lose the opportunity to propose additional health claims to demonstrate grain’s beneficial effects of this crop.

4. ENEA research activities on buckwheat

The present section provides an overview of ENEA research activities carried out to:

- verify the adaptability of buckwheat to some Italian high-hill and mountain areas
- formulate and characterize a range of healthy foods containing *F. tataricum* flour

Buckwheat is an alternative crop that may contribute to the development of agriculture in some marginal areas in Central and Southern Italy. Starting from 2004, ENEA has carried out agronomic trials comparing a lot of buckwheat varieties cultivated in different experimental sites (Fig.1), in order to search the most adapted varieties. The husbandry practices suggested that the cultivation is likely to be limited to mountain environments starting from 1,000 m a. s. l., allowing to obtain a grain yield up to 2 t/ha (Brunori et al., 2005; 2006).

Fig.1. Experimental sites in South Italy.

ENEA laboratories have studied the potentialities of buckwheat as an ingredient for the production of functional foods. Flours from different *F. tataricum* varieties and bakery products (biscuits, crackers and bread) made with Tartary buckwheat flour (Fig.2) were chemically characterized in order to evaluate total polyphenols amount and antioxidant activity (by spectrophotometric assays) and to quantify rutin, quercetin, fatty acids and tocopherols (by chromatography technique). Tartary buckwheat flours and derived products assayed showed high levels of antioxidant compounds (Tolaini et al., 2013).

Fig.2. Bakery products containing Tartary buckwheat flour developed by ENEA research activities.

5. Conclusion

There is an increasing societal awareness of the opportunities to improve life quality through healthy eating and of the contribution that sustainable production can make to improvement of the overall environment. The preference of consumers for quality, convenience, diversity and health, and their justifiable expectations of safety, ethics and sustainable foods production serve to highlight the opportunities for innovation. As a response to these requirements, the Charter of Milan is designed to lead the way into the future, providing the principles and actions to be undertaken, to guarantee future generations a healthier, fairer, and better planet. The Charter of Milan is a platform that is open to all, upon which will be collated the experiences and outcomes of those who participated in Expo Milano 2015, and which will become a collective manifesto on the role of foods and nutrition as a way of improving quality of life, to be used to raise the consciousness of both politicians and society as a whole. Taking its cue from the central theme of Expo 2015, which is "foods", the Charter of Milan takes this one step further, to the idea of "providing foods" (www.expo.rai.it/carta-di-milano-expo2015).

In this context, agro-food research should lead to the exploitation of minor crops as a valid and sustainable alternative for marginal areas, and as an ingredient for the production of more quality and nutritious foods. ENEA activities were carried out with this purpose and our results showed that Tartary buckwheat may represent a sustainable crop for those high-hill and mountain districts of Italy where this crop was never grown before, providing additional income to farmers; furthermore, chemical characterization of prototype foods obtained with Tartary buckwheat flour showed their high antioxidant profile, suggesting their potential use as functional foods.

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