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Food choices and climate change – perspectives and challenges for the "new" old crops of the future

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Abstract

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Despite their resistance to abiotic stress and their potential to supply key nutrients to humans, reducing the risk of diet-related diseases, some food plants are often in the category of neglected and underutilized crops. A number of legumes and cereals have a long history of cultivation in Europe and are a part of the historical food identities of different countries, yet they are not popular with farmers, food producers and consumers these days. Additionally, a number of indigenous forms and old varieties traditionally used in Bulgaria lack basic information on their nutritional value and/or data on their interest, which is a significant barrier to their wider cultivation and marketing. Aim of the study was to explore traditions in cultivation and consumption of cereals and pulses in Bulgaria, focusing on several archaeophytes, that are currently in decline and/or are mainly imported from other parts of the world (e.g., rye, chickpea, pea, etc.). Scientific and grey literature was analyzed to elucidate the specificities and limitations for revival of those crops in the frame of changing climatic conditions and recent developments in Bulgarian agriculture. The limited production of the target crops is parallel to the import of cheaper raw ingredients. There is an increase of the market share of plant-based protein-rich products and revived interest in local cuisine; however, local genetic resources are rarely part of the foodscape or market strategy of the producers. The representation of the selected crops in seed banks and the opportunities to develop entrepreneurship based on local and traditional foods and beverages amidst global change is discussed.

Keywords: plant genetic resources; plant-based foods; traditional knowledge; protein-rich crops

Introduction

Future sustainable growth depends on ecologically-friendly agriculture and natural resources conservation whilst ensuring production of enough food for the growing human population (Çakmakçı et al., 2023). Climate change projections for the Balkans foresee intensification of abiotic stresses, like water scarcity, higher average temperatures, soil salinity/alkalinity, more extreme weather events, that will further boost biotic stresses, e.g., more frequent incidence of insect/pests, diseases, and weeds, pollinator loss, etc. (Bocheva et al., 2017; Shahzad et al., 2021). While arable land and pastures in the European Union (EU) are set to decline marginally, 54.7% more pulses and 33.3% more soya beans are expected to be produced till 2032 (European Commission, 2023). The latter is part of the EU protein transition policy incentives aimed at increased local production of plant proteins coupled with income support to farmers growing protein crops. Aside of the pedo-climatic conditions various cultural, economic and socio-political reasonings are preventing cultivation and consumption of certain

crops that have become locally and/or regionally neglected (Chimonyo et al., 2022). Many European nutrient-rich foods have fallen out common use, even though they thrive in European climates and can be vital for climate-resilient food production. Based on underutilized crops like rye and pre-Columbian legumes, which are resilient to stresses, such foods have the potential to provide essential nutrients and to enhance diets (Scarano et al., 2021). Neglected crops would possibly hold a key role in diversification of arable agriculture securing yields in the current dynamic climate situation (Labeyrie et al., 2021). These crops often require fewer inputs to produce and can thrive in a variety of environments, making them suitable for sustainable agricultural practices and also help maintain soil health, biodiversity and food security (Rusheva, 2023; Singh et al., 2024). Additionally, neglected and underutilized crop species contain health-promoting bioactive components that expand dietary diversity and counteract against malnutrition caused by overreliance on major crops (Ali & Bhattacharjee, 2023). The aim of the present study is to summarize current state of knowledge related to rye, chickpeas and peas. Their origin is from the Near East and/or Mediterranean area but were introduce in the European agriculture in pre-historic times (Neolithic era). Thus, we want to elucidate benefits and limitations for their cultivation and consumption in Bulgaria.

Materials and Methods

Data on production and usage were collected from published statistical datasets (Bulgarian Ministry of Agriculture and Food and FAO) and scientific publications (2015 onwards) extracted from worldwide recognized scientific databases (ScienceDirect, Web of Science, PubMed, and CABI). The keywords we used for the enquiries were Latin and English "name of the plant taxa" in question (rye, chickpea, pea) combined with "production", "consumption", "use" or/ and "utilization".

Results and Discussion

Rye (Secale cereale L., Poaceae)

Rye cultivation in the early ages took place independently in different areas in the Near East and the Mediterranean area (Parat et al., 2016). However, nowadays Northeast Europe is the main rye producing region with decreasing cropping area (Korzun et al., 2021). The strong winter hardiness of rye culture makes it preferred cereal for northern areas, where conditions are suboptimal for other crops. Hence, Poland and Germany are the leading rye grain producers in the EU, competing with Russian Federation on a global scale (FAO, 2024). In southern Europe, culture conditions are currently more favorable to other cereals, and rye is mainly present as a weed or used as forage (Parat et al., 2016). In the past ergot was a major issue in rye cultivation caused by *Claviceps purpurea* (Fr.) Tul. that infects wide host range with over 400 different grass species, including wheat and triticale. Hence, toxic ergot alkaloids continue to occur in food and feed samples and European Union prescribed strict limits for the use of rye for human consumption to 0.5 g/kg (Miedaner et al., 2021). While ergot alkaloids are deemed undesirable in animal feeds, according to European regulations, maximum levels are not currently established (Schrenk et al., 2024; Shindarska et al., 2016). On the other hand, rye contains health promoting compounds like fibers (arabinoxylan, β-glucan, fructans, lignin), phenolic acids tocopherols, phytosterols, starch, proteins, etc. that support functioning of metabolic and digestive systems (El-Mahis et al., 2023). Rye is especially beneficial for slowing down to glucose flux and lowering cholesterol levels that makes it suitable for diabetic and metabolic syndrome patients (Jonsson et al., 2018). Furthermore, rye has similar levels of proteins (about 10%) with wheat, but contains more than two times crude fibers (Németh & Tömösközi, 2021). As a result, rye breads have higher moisture content and denser structure that was traditionally disregarded by Bulgarians and associated with poverty and times of scarcity (Avginova-Nikolova, 2017). Currently rye breads are accepted as dietary and suitable for diabetes patients, as well as a base for traditional beverage boza, which sustains rye production (Figure 1). All parts of the rye plant are used for various purposes, including bread, pasta and bakery goods making; brewing and distilling of various alcoholic and non-alcoholic beverages; packaging materials (straw); cosmetic products; forages (green chop, haylage) and in pasture mixes (Table 1). One of the currently attractive applications is the opportunity to suppress pests and weeds and also to reduce soil erosion, an important trait for organic farming, as well as green manure/cover crop (Korucu et al., 2018).

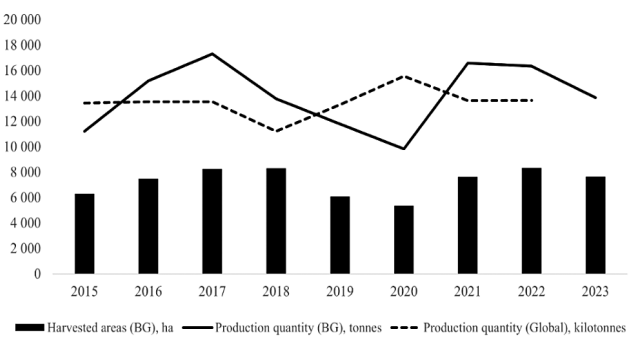

Fig. 1. Rye production in Bulgaria
(FAO, 2024; Ministry of Agriculture and Food, 2024)

Table 1. Usage of rye, chickpeas and green peas

Crop	Product/ plant part	Utilization	Reference
Rye	entire plant	cover crop	(Korucu et al., 2018)
		pasture mixes	(Kallenbach et al., 2006)
	entire plant (green)	haylage	(Choi et al., 2016).
	grain	brewing	(Zhuang et al., 2017)
		distilling	(Brzozowski et al., 2023)
		forage	
	bran	biofuel, cosmetics, packages, fruit protection, feed and food additives	(Dziki, 2022)
		yeasts substrates	(Drzymała et al., 2020)
	grain (flour)	food, food additives, packaging	(Michalska et al., 2008)
	rye straw	compost	(Zawadzińska et al., 2021)
	husk	baking additives, textile dyes	(Tassoni et al., 2020)
	straw	animal consumption	
Chickpea	grain and straw	animal consumption	(Bampidis & Christodoulou, 2011)
	hull	human consumption	(Niño-Medina et al., 2019).
	immature pods	human consumption	(Geervani, 1991)
	leaves	human consumption	(Ibrikci et al., 2003)
	grain (flour)	human consumption	(Kaur & Singh, 2005)
	peels	cellulase enzyme production	(Tassoni et al., 2020)
	pods	food ingredients	
Green peas	pods	bio-butanol production	(Tassoni et al., 2020)
		animal consumption	
	grain	human consumption	(Wu et al., 2023)
	entire plant	animal consumption	(Petkova et al., 2022)

Chickpea (Cicer arietinum L., Fabaceae)

Chickpea originates also from the Near East and reached the Balkans during the Neolithic era (Marinova, 2016). Main production areas are in India, producing nearly 70% of global yields, followed by Pakistan and Türkiye (FAO, 2024). Heat and drought-resistance is among the main advantages of some chickpea varieties and together with atmospheric nitrogen-fixation make it prospective crop for the changing climates in southern part of Europe. Although, numerous chickpea varieties and landraces are preserved in Europe, the about 80 year-long lack of interest in its breeding has to be overtaken (Rocchetti et al., 2020). In Europe, production is traditionally concentrated in Italy and Spain, however, the current popularity of Asian cuisines and the promotion plant protein consumption by the EU have created increasing demand for chickpeas, among other legumes (Tassoni et al., 2020). In Bulgaria, traditional cultivation is concentrated in the Southern part of the country, where dry chickpeas are cooked in stews and consumed as a snack (Figure 2). Short spike in chickpea cultivation in 2017–2019 period was a result of state subsidies for legume production, that had only limited effect on farmers. However, food production using chickpeas is significantly boosted, so as the growing imported quantities of raw chickpea in the EU. In addition, to human nutrition chickpeas are used also for animal feed and for obtaining of enzymes, etc. Aside of high protein levels (about 20%) chickpeas contains beneficial carbohydrates, isoflavones, minerals, dietary fibers, polyphenols, unsaturated fatty acids, carotenoids, α-tocopherol, folic acid and other vitamins (Grasso et al., 2022; Wang et al., 2021). Hence, chickpeas are found to possess hypo-cholesterolemic, anti-diabetic, anti-cancerous, and anti-inflammatory activities and their inclusion in the diet could be beneficial, especially for prevention of cardiovascular diseases (Grasso et al., 2022).

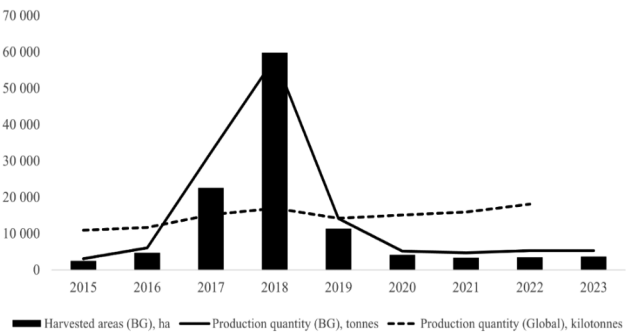

Fig. 2. Chickpea production in Bulgaria
(FAO, 2024; Ministry of Agriculture and Food, 2024)

Peas (Lathyrus oleraceus Lam., Fabaceae)

Out of the three reviewed crops, peas are most commonly cultivated and used, holding about a quarter of global pulse production (Wu et al., 2023). Interestingly, in Bulgaria pea consumption is relatively new (since the end of 19th century) and especially in northern parts of the country it was considered mainly as forage plant (Popov et al., 1966). However, genetic diversity of currently grown field pea cultivars is quite narrow and pea production suffer of numerous pests, fungal and viral diseases due to the changed climate conditions and human decisions (Lake et al., 2021). Many landraces and old cultivars are susceptible to lodging, an especially undesirable trait for mechanical harvesting systems, which hampers their inclusion in breedinwg programs (Annicchiarico et al., 2017). Peas are rich in proteins, starches, non-starch polysaccharides, and dietary fiber of which pea protein gains main interest in the frame of protein transition (Shen et al., 2022). The crude protein content of peas varies significantly (14–31%) with significant amounts of lysine and is suitable both for human and animal nutrition (Hartl et al., 2024). Along with nutritional value pea protein was found to possess antioxidant, antihypertensive, and microbiome-modulating activities, which is complemented by flavonoids and phenolic acids (Ge et al., 2020). High carbohydrates amounts are useful not only for the food/feed industry, but also for production of biofuels.

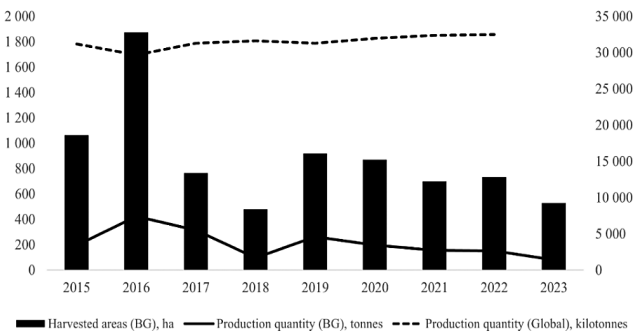

Fig. 3. Green peas production in Bulgaria
(FAO, 2024; Ministry of Agriculture and Food, 2024)

Conclusion

Limited production of multifunctional crops like rye, pea and chickpea, among others, in Bulgaria is limiting food security and sovereignty of the country as growing global demand for plant proteins would make their import ever more complicated and costly in the future. Thus, important health and environmental benefits of production of the three crops should be considered for their further promotion not only among farmers, but also among consumers. In the frame of the climate changes diversification of food choices is crucial not only for maintenance of good health and wellbeing, but also for alleviating environmental pressure on agroecosystems.

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Conflict of interest

Authors declare no conflict of interest.

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