XXVI INTERNATIONAL
ECO-CONFERENCE® 2022
21–23th SEPTEMBER

XII SAFE FOOD

PROCEEDINGS

NOVI SAD, SERBIA

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2022

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ECOLOGICAL MOVEMENT OF NOVI SAD

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Original Scientific paper

IMPORTANCE OF BROAD BEAN IN THE DIET – POSSIBILITY OF MORE RATIONAL USE OF MAIN AND BY-PRODUCTS

Abstract

Broad bean is rich in quality proteins, which is why we use it in the diet of humans and domestic animals. Ripe bean seeds can be used as a stew or ground, and flour mixed with grain flour in a certain percentage is an excellent raw material for making various bakery products. The aim of this study is to point out the benefits of improving broad bean production in the Balkans use of its main and by-products. In addition to the main product, mature grain, there are harvest residues that have multiple applications.

Key words: *biomass, broad bean, by - products, nutrition, climate change*

INTRODUCTION

Broad bean (lat. *Vicia faba* sect. Faba Cubero; *Faba vulgaris* Moench; eng. Broad bean; fra. *Feve*; rus. *Kormovie bobi*) is an annual plant from the legume family (*Fabaceae*), genus *Faba*, with large seeds used in the diet as well as beans .The genus *Faba* has one cultural species – *Faba vulgaris* – cultural broad bean and one wild species that grows in Algeria – *Faba pliniana* (Murat). According to archaeological data, the cultivation of this plant began about 8,800 years ago in the eastern

Mediterranean. The largest areas are in China (806,858 ha), followed by Ethiopia, Morocco, Peru, etc. In Serbia, broad bean is grown on small areas, mostly in backyards. In addition to the main product, which is usually mature grain, there is harvest waste that is used in a similar way as other grain legumes. For human consumption, unripe or ripe grain are used. The work of breeders has created several types of broad bean that differ in the way they are used (vegetable and livestock). With the introduction of beans into production, it was pushed to the narrower Mediterranean area, but also to northwestern Europe. Cultivated beans are divided, according to the size of the seeds, into three varieties: large-seeded beans – *Faba fulgaris* var. major, medium-sized (horse bean) – *Faba vulgaris* var. equina and small-seeded beans – *Faba vulgaris* var. minor. Large-seeded broad bean is more of a garden crop. The weight of 1000 grains is 800-1200 g, and sometimes up to 2400 g. Small-seed and horse beans are grown as field crops and are used to feed livestock. They differ in seed size. Small-seeded beans have a weight of 1000 grains, 300-650 g, and horse beans 650-800 g (Lakić et al., 2018; 2019). Broad bean is cultivated for seeds rich in quality proteins. We use it in the diet of humans and domestic animals. Board bean seed is suitable for canning (Lakić et al., 2018). Broad bean is used as vegetables. Young legumes or seeds, rich in nutrients, are used in the diet. 100 grams of mature raw seeds contain over 25 grams of protein, carbohydrates, fiber and minerals. In folk medicine, broad bean seeds are used as a diuretic, expectorant or as a tonic. In addition to the great nutritional value, this seeds also contain a significant percentage of anti-nutrients that are decomposed by heat treatment. People who have problems with glucose-6-phosphate dehydrogenase (G6PD) deficiency, may have an broad bean seed allergy. Broad bean is rich in the amino acid L-dopa, which is a precursor of dopamine, so it is recommended for people with Parkinson's disease, because their body weakly produces dopamine. Harvesting leftovers can be used as coarse fodder. The grain of small-seeded varieties of broad bean is used mainly in the diet of ruminants and non-ruminants, then caged birds, and that without prior peeling. The harvest residues of broad bean are suitable for composting because they contain a higher percentage of nitrogen compounds. Chopped can be used as mulch in the fields or as a mat for domestic animals. From the agronomic point of view, the best way is to plow the crop residues, especially in conditions when farmers have less and less quality manure or compost at their disposal. Board bean is also of great agro-technical importance, because, like all nitrogen-collecting plants, it enriches the soil with mineral nitrogen compounds. In recent times, it is increasingly serving as a raw material for the production of bio-fuels (Lakić et al., 2018). One of the significant possibilities of reducing the emission of greenhouse gases is the use of plant residues from agricultural production for energy purposes (Popović et al., 2020a, 2020b). Varieties of small-seeded and medium-seeded broad bean are grown as fodder plants and their seeds. We grow broad bean as a fodder plant, most often in combined sowing with millet-like cereals, and we make silage from above-ground biomass. Harvest residues of broad bean straw, have up to 10% of total protein and are suitable coarse food for domestic ruminants. In some countries, straw is briquetted after the broad bean harvest and used as a heating material. Broad bean is also of great agro-technical importance, is nitrogen-collecting plants, they enrich the soil with mineral nitrogen (Lakić et al., 2018).

The time of harvest determines the further procedure of using the grain. The broad bean reaches the stage of maturity, depending on the type of variety and the method of use, in 85 to 200 days from the emergence of plants. Broad bean grown in combined sowing with cereals is used to make silage and is mowed with forage harvesters when the lower pods on the trees are in the phase of milk maturity. Mown biomass is ensiled just after mowing. The broad bean ripens quite unevenly and the seeds from the lower pods are shed, so in some countries, to accelerate ripening, the crops are treated with desiccants at 10-15 days before the harvest. Dried seeds break a lot during threshing, despite the necessary adaptations that we perform on harvesters before harvesting. On small areas, broad bean can be harvested in two phases, first mowing the plants, drying them in the swaths and then threshing with harvesters (Lakić et al., 2018; Janković et al., 2019). The aim of this paper is to examine the possibility of more rational use of broad bean and harvest residues of it in order to protect the environment.

MATERIALS AND METHODS

Bean sowing is done in early spring because it tolerates low temperatures well. In our conditions, sowing should be done in mid-March. The amount of seeds depends on the size of the seeds and the number of plants per unit area. The number of plants depends on the variety (more in small seeds and vice versa), and especially on the amount of precipitation in the growing area. In drier regions, 20-40 plants per m^2 are sown, depending on the variety, and in wetter areas, the number of plants per m^2 increases to 40-60 plants. Based on the number of plants, the weight of 1000 grains and the use value, it is easy to calculate the amount of seeds in $kgha^{-1}$. Sowing is done in a wide row, with a distance between rows of 50-60 cm. If the broad bean is used for silage, the width of the rows is smaller 30-40 cm. Depth of sowing depends on the type of soil and varies from 5-8 cm. The data presented in the paper are presented in Tables and Figures.

RESULTS AND DISCUSSION

Legumes include various types of vegetables such as beans, peas, broad bean, green beans, *Cicer arietinum* (chickpeas), peanuts, lentils (lentils) and soybean. They are nutritious and energetically strong, they are a source of protein and complex carbohydrates, they are rich in minerals such as iron, phosphate, potassium, calcium, magnesium and zinc, B vitamins, as well as fully or partially soluble fiber, which in intestines form a gel. Legumes are digested slowly and slowly turn into blood (Glamočlija et al., 2015). The main grain legumes (60), information on distribution and consumption are shown in Table 1.

Productivity of broad bean. The yields of mature broad bean are 3,000 to 3,800 kg ha^{-1}; the yields of aboveground biomass depend on the ratio of broad beans and sown cereals. In favorable conditions of the water regime, 50 to 80 t ha^{-1} can be achieved (Lakić et al., 2018).

Table 1. The main grain legumes, with information on distribution and consumption, Ildikó Schuster-Gajzágó 2022, http://www.eolss.net/sample-chapters/c10/e5-02-02.pdf

Common name	Latin name	Distribution	Consumption
Soybean	*Glycine max* L.	USA, Brasil, China, Argentina, Japan	Human consumption, mainly processed products (soy meal, concentrate, isolate, soy milk, fermented products), animal feed
Faba bean	*Vicia faba* L.	Central Asia, South America, Europe, ...	Human consumption, and canning, freezing The dry harvested seeds are used as animal feed.
Common bean	*Phaseolus vulgaris* L.	India, Brazil, France, UK, Russia, German, Ukraine	Human consumption green in pods (canning, freezing) or dry seeds.
Cowpea	*Vigna unguicu lata* L.	Mediterranean area, Africa, Asia	Human consumption, it is eaten as dhal made from soaked, dehulled seeds
Pea	*Pisum sativum* L.	Europe, North America	Human consumption, combining crop-animal feed

After harvesting, seeds should be dried to 10-14% of water and stored in warehouses where fumigation must be done, to protect them from barn pests. Malathion, Aluminum phosphide, Methyl bromide (Haltox preparation) or some other insecticide fumigant is used for fumigation. The yield of harvest residues of grain legumes, in addition to time and method of harvesting, is influenced by other factors, such as species, variety, method of cultivation, applying of agro-technics, agro-ecological conditions and so on (Lakić et al., 2018).

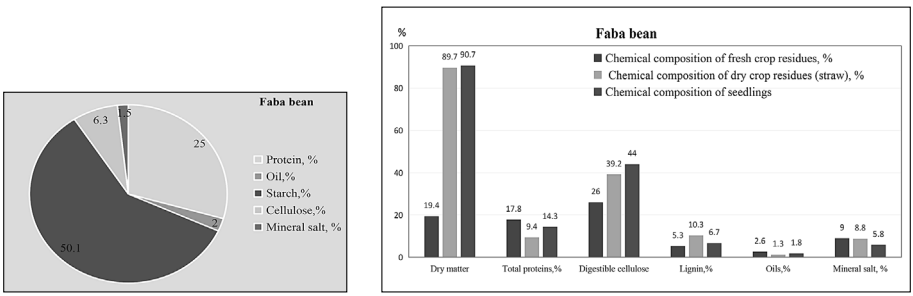
Chemical composition of broad bean seeds – Broad bean seeds contain 25-35% protein, depending on the variety and growing conditions. In addition to protein, it contains about 50% no-nitrogen extractives and up to 2.0% oil. Straw contains 7-20% protein. Broad bean is used for human consumption, for livestock nutrition and for vegetable fertilization. Mature grain is ground, and flour is used as a protein component in concentrated feed mixtures for cattle, especially for calves. Broad bean is grown as a side crop, but it can be grown in a mixture with corn for silage. Good silage is made from broad bean. The chemical composition of legumes is shown in Table 2. Similar to bean seed is bean seed which contains 22.6% protein, 42.2% starch and 1.8% oil, tab. 2. Road bean has partially soluble fiber, and due to the combination of fiber and folic acid, it reduces the risk of stroke, as well as heart and blood vessel diseases. It is recommended for diabetics and pregnant women, but not for kidney patients. However, the shell contains pectin, which is difficult to digest, so broad bean is avoided in diseases of the digestive organs. This is one of the favorite foods of vegetarians because it contains a large amount of protein. It does not contain gluten, so it is also suitable for the diet of people with celiac disease. In many people, broad bean cause bloating and gas, so to alleviate this, it would be desirable to use spices such as cumin, mint leaves, ginger and garlic.

Table 2. Chemical composition of grains legume, %

No	Plants	Protein %	Oil %	Starch %	Cellulose %	Mineral salt, %
1.	Faba bean-*Vicia faba-F. vulgaris /bob*	25.1	2.0	50.1	6.3	1.5
	Phaseolus vulgaris /obični pasulj	22.6	1.8	42.2	23.0	4.1
2.	*Pea – Pisum sativum / grašak*	23.0	2.5	55.0	5.6	3.1
3.	*Grass pea-Lathyrus sativus / sastrica*	31.0	20.0	41.0	10.1	1.3
4.	*Cowpea-Vigna ungiculata / vigna*	25,5	1.7	40.5	4.3	3.5
5.	*Lentil – Lens culinaris / sočivo*	28.9	2.1	50.1	7.9	2.4
6.	*Cicer arietinum / Naut*	23.8	4.3	44.5	9.8	3.3
7.	*Lupinus luteus / žuta lupina*	42.0	4.5	42.5	6.0	3.0
8.	*Arachis hypogaea / peanut*	25.4	52.2	19.2		
9.	*Common vetch-Vicia sativa; grahorica/hay-dm*	24.0	1.2	37.0	4.5	3.4
10.	*Soy – Glycine max /soja*	38.5	20.1	32.5	6.7	4.1

Source: http://www.feedipedia.org/node/4926; Glamočlija et al., 2015.

Legumes are rich sources of protein as the seeds contain 200-250 g protein/kg. The protein content of cooked legume seed (70-100 g/kg cooked food) is similar to that of bread (80-90 g/kg), but still much higher than for potato (15-22 g/kg). Legume seeds are rich in lysine and poorer in sulfur-containing amino acids (methionine and cysteine) compared to cereals. Lysine is the first limiting amino acid so it is important that legumes complement cereals in lysine balance. Legume proteins are composed of several



a. b.

Figure 1. Chemical composition of Faba bean grain (a.) and of fresh and dry harvest residues (b.)

thousand specific proteins. About 70 to 80 % of the crude protein in legume seeds is storage protein. The non-storage proteins are enzymes, enzyme inhibitors, hormones, transporting, structural and recognition proteins (Ildikó Schuster-Gajzágó 2022).

The chemical composition of the harvested residues of grain legumes depends on the time of harvest, which, depending on the way the grain is used, may be in technological maturity (occurs at the time of pod formation), then in the doughy or full maturity phase. The yield of broad bean in the world is over 1.6 t / ha. The highest yields are in Europe and Asia (5-2.5 t / ha), and the lowest yields are in South and North America and Africa (600-800 kg / ha). Harvest biomass has the highest nutritional value during pod formation (Table 3, Fig. 1b).

Table 3. Chemical composition of fresh and dry harvest residues of Faba beans, %

Parameter	Dry matter	Total protein	Digestible cellulose	Lignin	Oils	Mineral salt
Faba beans bob	Chemical composition of fresh crop residues of legumes, %					
	19.4	17.8	26.0	5.3	2.6	9
	Chemical composition of dry crop residues of legumes, %					
	89.7	9.4	39.2	10.3	1.3	8.8
	Chemical composition of legume seedlinds, %, Constanza et al. (2012)					
	90.7	14.3	44.0	6.7	1.8	5.8

Source: http://www.feedipedia.org/node/4926

With the physiological maturation of plants, the nutritional value of harvest residues decreases. If the harvest is done in single-phase with harvesters in the phase of full maturity of seeds in pods, the harvest residues, as a whole, have the lowest nutritional value with increased content of non-nutrients (Table 3).

Remains in the field after harvesting legumes for grain have a great and diverse use value, which is shown by their chemical composition. Harvest residues of all legumes can be used as coarse fodder, but they do not have the same nutritional value.

Producers dry this biomass in the field, then bale it and use it as fodder, which does not lag behind alfalfa hay in terms of quality. Dry biomass of harvest residues of peas, fodder peas, lentil and broad bean grown for grain has a higher nutritional value, while in other legumes it is less usable due to the higher content of non-nutritious substances (lignins, hemicelluloses and silicates). If used for certain species of domestic animals (sheep or cattle) it should be treated with additives – ammonia or calcium hydroxide to increase the coefficient of digestibility. Harvest residues are suitable for composting because they contain a higher percentage of nitrogen compounds. Chopped can serve as mulch in the fields as a mat for domestic animals. At recent times, it is increasingly serving as a raw material for the production of bio-fuels. From the agronomic point of view, the best way is to plow the crop residues, especially in conditions when farmers

have less and less quality manure or compost at their disposal. This biomass in the country decomposes quickly due to the increased participation of organic nitrogen compounds.

Fresh harvest leftovers of broad bean. After the successive manual harvesting of unripe broad bean green pods, 20-30 t ha^{-1} of vegetative biomass remains in the field, which consists of green trees, leaves and unharvested small, unripe pods. This biomass in total dry matter has 14-20% of total proteins (Alibes et al., 1990). The amount and digestibility of proteins depend on the share of leaves in the total yield of these harvest residues (McVicar et al., 2013). If it is planned to use harvest residues as fodder, the biomass should be cut as soon as possible after the pod harvest, because its nutritional value decreases every day. Mowing is best done with a forage harvester. Mowed biomass can be used fresh as fodder. However, the use of fresh biomass of crop residues in the diet of domestic ruminants reduced the utilization rate of dry matter, total protein and cellulose (Louw, 2009). Therefore, it is more expedient to use it to make silage. Baddeley and Walker (2014) point out that vegetative biomass of board bean is low in sugars and in order to produce quality silage, it is necessary to mix it with grasses or biomass of some cereals (for example corn, sorghum or millet). This biomass can be used as mulch or used for ploughing in. Easily degradable organic compounds decompose rapidly in the soil and release significant amounts of nitrogen and potassium.

Leftovers of broad bean harvest. Broad bean is a legume that has multiple uses in the diet of domestic animals and humans. Legumes, unripe and ripe grain serve as food for humans, while the main product and all leftovers can be used in the diet of domestic animals, starting with the harvest residuals, ie straw. Residues remaining after machine harvesting of mature grain participate in the total biomass with more than 60%. According to chemical analyzes, they are rich in total proteins, digestible celluloses and mineral salts, but also a large amount of indigestible compounds that diminish the nutritional value of this bulky fodder. In order to increase the value of straw, as a bulky fodder, it should be chopped and treated with additives before use to neutralize hemicelluloses and tannins (McVicar et al., 2013). Other ways to use large biomass of crop harvested residues are to obtain bio-fuels. Above-ground biomass after pod harvesting is very suitable for use for bio-energy purposes. It is rich in celluloses which are technologically converted into soluble sugars, the basic raw material for the production of alcohol – ethanol or for the production of biogas. Petersson et al. (2007) state that the technology of obtaining bio-ethanol and biogas from lignocellulosic broad bean bio-mass, has been developed in Sweden. Harvesting residues are ploughing in, in order to increase soil fertility, and in some countries this plant is also grown as a cover crop or siderate to repair the structure and chemical composition of poor soils.

Residues after grain peeling. Edible broad bean grains are used to prepare basic food. However, they can be ground and the produced flour is mixed with wheat flour for baking bread and bakery products. In order to increase the digestible value of flour, it is necessary to prepare the grain beforehand, which means separating the seed coat. The grains have large amounts of oil. These compounds are first separated and then the remaining mass is ground to obtain defatted flour. The share of the seed coat in the total

mass of grain is different and depends on the type, variety, growing conditions and applied agricultural techniques. This by-product has significant amounts of polysaccharides, proteins and mineral salts. Therefore, it can be used as a concentrated fodder or as a raw material in further industrial processing. The variation in chemical composition is influenced by the more factors.

Seed coat of broad bean. The nutritional and digestible value of large-seeded broad bean grains is significantly reduced by the husk, which accounts for about 12% of the total mass. Before use in the diet of unripe or ripe (dry) broad bean, the wrappers are separated from the grains by soaking and rubbing. This results in a food product with more protein and starch, and less cellulose. The nutritional value of grain is highest in immature seeds (Crépon et al., 2010). Separated shells are rich in digestible celluloses (up to 50% dry matter) and digestible proteins (above 6%), but also tannins. With prior preparation, which includes the treatment of biomass with additives, they can be used in the diet of domestic ruminants. The grain of small-seeded varieties of beans is used mainly in the diet of ruminants and non-ruminants, then cage birds, without prior peeling (Aleksić et al., 1999).

CONCLUSION

Edible grains of broad bean are used for food preparation. The grain can be ground and the flour produced is mixed with wheat flour for baking bread and bakery products. Utilization of secondary residues of broad bean is of great importance. Biomass can be used for the production of compost or earthworms. Another way of using these secondary products is ploughing in during the basic tillage. The grain of small-seeded varieties of beans is used mainly in the diet of ruminants and non-ruminants, then caged birds, and without prior peeling.

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ZNAČAJ BOBA U ISHRANI – MOGUĆNOST RACIONALNIJE UPOTREBE GLAVNIH I SPOREDNIH PROIZVODA

Izvod

Bob je bogat kvalitetnim proteinima zbog čega ga upotrebljavamo u ishrani ljudi i domaćih životinja. Zrelo seme boba možemo koristiti kao varivo ili ga samleti, a brašno pomešano sa brašnom žita u određenom procentu predstavlja odličnu sirovinu za izradu različitih pekarskih proizvoda.Cilj ove studije je da se ukaže na prednosti unapređenja proizvodnje boba na području Balkana, kao i na mogućnosti racinalnije upotrebe glavnih i sporednih proizvoda boba. Osim glavnog proizvoda, zrelog zrna, ostaju žetveni ostaci koji imaju višestruku primenu.

Ključne reči: *biomasa, bob, sporedni proizvodi, ishrana, klimatske promene*

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