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Naučna kritika

ZNAČAJ TRITIKALEA U ISHRANI ŽIVOTINJA*

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Kratak sadržaj: Žita su sa agronomskog i privrednog značaja najvažnija grupa ratarskih biljaka. Tritikale je savremeno žito, odnosno hibrid dobijen ukrštanjem pšenice i raži, s tim što je nasledio sposobnost raži da preživi jake mrazeve, ali ima veću proteinsku vrednost, dok je veći prinos zrna i povećanu tolerantnost na ražanu glavnicu nasledio od pšenice. Na koji će se način koristiti tritikale zavisi od osobina sorte. Sorte krupnog i ujednačenog zrna sa povećanim sadržajem ukupnih proteina u odnosu na skrob i koje su po hemijskom sastavu bliže pšenici, koriste se za pripremu koncentrovane stočne hrane, kako za živinu, tako i za nepreživare i preživare. Sorte koje obrazuju veliku biomasu, slično raži, služe za spremanje voluminozne stočne hrane kao sveže ili silaže, senaže i sena. Hranljiva vrednost zrna tritikalea je na nivou pšeničnog, s tim što ima nešto više aminokiseline lizina. U pogledu zastupljenosti esencijalnih aminokiselina, pojedinih minerala i vitamina, zrno tritikalea može zadovoljiti značajan deo potreba domaćih i gajenih životinja. Tritikale, kao i ostala zrnasta hraniva, standardni su deo obroka za ishranu domaćih i gajenih životinja, posebno u većem procentu kada je životinjama potrebno više energije. U zavisnosti od vrste domaće životinje kao i tipa obroka, tritikale može činiti njegov značajan procenat. Prednost tritikalea nad drugim pravim žitima je taj što ima veći prinos, brži prolećni porast i mogućnost dužeg roka kosidbe za zelenu stočnu hranu jer ogrubi kasnije nego npr., raž ili ovas. Zbog navedenih prednosti tritikale je pogodan za setvu, posebno u zemljama u razvoju.

Ključne reči: tritikale, ishrana životinja, žita, hemijski sastav, hranljiva vrednost

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UVOD

Jednogodišnje vrste porodice trava (fam. *Poaceae*) koje se gaje radi zrna, ali i nekoliko vrsta iz drugih botaničkih porodica čiji se plodovi koriste na sličan način, svrstane su u grupu žita. Žita su sa agronomskog i privrednog značaja najvažnija grupa ratarskih biljaka. Od relativno novih vrsta koje su nastale radom čoveka, najvažniji je pšenično-ražani interspecijes hibrid nazvan tritikale. Tritikale je nasledio sposobnost raži da preživi jake mrazeve, ali ima veću proteinsku vrednost (više glutena) (*Amaya and Peña*,1991;*Boros*, 2002; *Tikhnenko* i sar, 2002; *Chelkowski and Tyrka*, 2003). Veći prinos zrna i povećanu tolerantnost na ražanu glavnicu nasledio je od pšenice.

POREKLO TRITIKALEA

Tritikale je prvo uspešno dobijeno žito koje je čovek stvorio ukrštanjem pšenice (*Triticum* sp.) i raži (*Secale cereale*), dveju različitih vrsta žita. Prvi stručni (naučni) naziv novonastale vrste bio je *Triticale hexaploide* lat., a izveden je od naziva roditeljskih biljaka. Kako navode *Sapra* i sar, (1972), škotski botaničar Alexander Stephen Wilson (1827–1893) je godine 1875. dobio prvi interspecijes hibrid pšenice i raži. Dobijeni interspecijes hibrid nije davao plodno potomstvo zato što roditeljske vrste imaju različit broj hromozoma. I pored tog nedostatka, početni rezultati bili su interesantni za nauku. Nakon toga, veliki broj naučnika iz oblasti bioloških nauka radio je na ukrštanju različitih sorti pšenice i raži u cilju dobijanja što boljih interspecijes hibrida. Prema viziji naučnika, tritikale bi trebalo da ima najbolje osobine oba roditelja, i to hlebno-pekarski kvalitet zrna pšenice i odličnu prilagođenost raži prema različitim agroekološkim i zemljišnim uslovima, kao i povećanu tolerantnost prema štetočinama i patogenima. Nova vrsta žita trebalo bi da se može gajiti uz manja ulaganja u tehnologiju proizvodnje i bila bi podesna za gajenje u zemljama u razvoju, s ciljem da se obezbede veće količine osnovne hrane za stanovništvo. Međutim, skromna saznanja iz oblasti genetike nisu davala odgovor kako rešiti problem koji nastaje ukrštanjem različitih vrsta a kao posledicu ima neplodnu F1 generaciju (*Laibach*, 1925). I pored toga, očekivanja i predviđanja svetske javnosti bila su da će novostvoreno žito, zahvaljujući velikom potencijalu rodnosti, značajno povećati proizvodnju hrane, kako u nerazvijenim, tako i u razvijenim zemljama. Poznati švedski genetičar *Arne Müntzing* (*Müntzing*,1979) napisao je da treba očekivati da će se sintetička vrsta tritikalea pridružiti starim žitima kao hrana za značajno uvećan broj ljudske populacije, kao i njihovih domaćih životinja. Po svojim morfološkim i proizvodnim osobinama, ova vrsta može imati veće prinose od roditeljskih vrsta, posebno u manje povoljnim agroekološkim uslovima i na siromašnijim zemljištima.

Prvi svetski rat prekinuo je rad na selekciji tritikalea u Evropi, ali je on nastavljen na američkom kontinentu. U Meksiku je osnovan Međunarodni centar za unapređenje proizvodnje kukuruza i pšenice (International Maize and Wheat Improvement Centre – Centro Internacional de Mejoramiento de Maiz y Trigo CIMMYT). Korišćenjem najsavremenijih genetičkih metoda rešen je prvi problem male fertilnosti novog interspecijes hibrida. Drugi korak bio je rad na povećanju kvaliteta zrna sa stanovišta upotrebe u ishrani ljudi (poboljšane hlebno-pekarske osobine) i domaćih životinja (povećan sadržaj svarljivih proteina). Stvaranjem ozimih sorti visokog i čvrstog stabla sa povećanim koeficijentom produktivnog bokorenja, tritikale postaje vrlo značajna krmna biljka čija se biomasa koristi u ishrani preživara kao sveža ili za spremanje sena, silaže i senaže. Neke sorte mogu se koristiti i kombinovano – ispašom i kosidbom. Kao krmna biljka tritikale se najviše gaji na američkom kontinentu, dok se u zemljama u razvoju proizvodi radi zrna za ishranu ljudi (Glamočlija i sar, 2017). Zahvaljujući ovom naučnom centru objedinjen je rad na oplemenjivanju i dobijeni rezultati, vezani za stvaranje novih genotipova tritikalea, dostupni su svim zainteresovanim selekcionerima i proizvođačima. Od početka rada u CIMMYT-u, stvoreno je više od 200 sorti tritikalea koje se mogu koristiti na različite načine (Glamočlija i sar, 2017). Danas ovaj Centar ima naučne stanice u više od 30 zemalja širom sveta.

Između dva svetska rata nastavljen je rad na selekciji tritikalea u Evropi. *Blakeslee and Avery* (1937) zapazili su da se ukrštanjem pšenice kao materinske biljke i raži kao donora polena najčešće dobijaju sterilni hibridi. Međutim, kad su tretiranjem kolhicinom indukovali poliploidiju, zaključili su da ovo hemijsko sredstvo udvostručuje broj hromozoma i dobijeno je plodno potomstvo. Na osnovu ovih saznanja naučnik *Pierre Civaudron* je 1937. godine u Francuskoj usavršio tehniku dobijanja plodnog potomstva ukrštanjem pšenice i raži. Primenom novih metoda selekcije stvorio je veći broj komercijalnih sorti dobrih proizvodnih osobina.

U Srbiji rad na dobijanju novih genotipova tritikalea, interesantnih za komercijalnu proizvodnju, ima višedecenijsku tradiciju. Naši naučni radnici su u novoj vrsti prepoznali žito koje može imati višestruku upotrebu u ishrani ljudi, domaćih i gajenih životinja, kao i u industrijskoj preradi. Oplemenjivanjem tritikalea u našoj zemlji bave se instituti koji su obezbedili velike banke gena, odnosno linija tritikalea iz inostranstva i iz sopstvenih ukrštanja (Glamočlija i sar, 2013).

PRIVREDNI ZNAČAJ TRITIKALEA

Na koji će se način koristiti tritikale zavisi od osobina sorte, odnosno od toga kom roditelju je ona više slična. *Boros* (2002) ističe da se sorte krupnog i ujednačenog zrna, koje su po hemijskom sastavu bliže pšenici, koriste u ishrani ljudi, ali i životinja. Sorte koje obrazuju veliku biomasu služe za spremanje voluminozne stočne hrane. Sorte krupnog zrna sa povećanim sadržajem ukupnih proteina u odnosu na skrob koriste se za pripremu koncentrovane stočne hrane, kako za živinu, tako i za nepreživare i preživare (*Belaid*, 1994; *Myer*, 2002; Đekić i sar, 2009). Značaj tritikalea u direktnoj ishrani ljudi ili posredno, kao stočne hrane, veliki je. Ipak, svetska proizvodnja tritikalea i drugih žita nije u srazmeri sa povećanjem broja ljudi. Podaci ukazuju na to da je u proteklih nekoliko godina ukupna proizvodnja žita u svetu bila manja od proseka, što može usloviti pojavu gladi na globalnom nivou (Glamočlija i sar, 2017). Proizvodnja žita po stanovniku u 2012. godini, koja je zbog velikih suša u Australiji i SAD iznosila 294 kg, bila je najmanja u proteklih 30 godina. *Blum* (2014) naglašava da jedno od rešenja predstavlja povećanje površina pod tritikaleom zahvaljujući činjenici da ova biljka može da uspeva i na marginalnim zemljištima, kao i u aridnim uslovima koji se sve više šire kao posledica globalne promene klime. Sorte tritikalea novije generacije imaju značajno poboljšane biološke osobine i kvalitetnije zrno, usled povećanog sadržaja belančevina, posebno lizina. Ove sorte pružaju mogućnost sveobuhvatnijeg korišćenja u ishrani ljudi, na primer za pečenje hleba pomešanog sa pšeničnim brašnom, ali i za ishranu domaćih životinja, za pripremu koncentrovane stočne hrane povećane hranljive vrednosti (*Baier* i *Gustafson*, 1996; *Aguirre* i sar, 2002).

ZNAČAJ TRITIKALEA U ISHRANI ŽIVOTINJA

Tritikale se u ishrani domaćih i gajenih životinja koristi na više načina. Zrno, zahvaljujući visokom sadržaju ukupnih proteina i ugljenih hidrata, služi za pripremanje koncentrovane stočne hrane (*Lorenz*, 2003). U ishrani domaćih životinja ono može zameniti zrno ovsa, krmnog ječma i drugih žita. Poređenjem sa plevičastim plodovima ječma i ovsa, zrno je daleko podesnije kao koncentrovana hrana za živinu i nepreživare zbog većeg koeficijenta iskorišćenja hrane (Đekić i sar, 2009).

Nadzemna biomasa koristi se kao voluminozna hrana za preživare. Za ovaj način korišćenja biomase tritikale se gaji kao čist usev, ali se može sejati i u različitim smešama sa ozimim i prolećnim mahunarkama (*Poysa*, 1985; *Blade* i sar, 2002; *Schwarte* i sar, 2005). Proizvedena biomasa koristi se sveža ili za spremanje silaže, senaže ili sena. Drugi način korišćenja nadzemne biomase tritikalea, gajenog u čistom usevu ili u smešama, jeste napasanjem domaćih životinja, najčešće kao obročna ispaša (*Redmon* i sar, 1995).

Hranljiva vrednost zrna je na nivou pšeničnog uz konstataciju da ima neznatno više aminokiseline lizina. Prema dosadašnjim saznanjima korišćenjem zrna tritikalea za spravljanje koncentrovane stočne hrane najbolji rezultati postižu se u ishrani živine (ćurke i kokoši) i muznih grla. Kao krmna biljka tritikale ima veći prinos od ostalih pravih žita. Najkvalitetnija biomasa dobije se kosidbom biljaka u početku klasanja, dok se najveći prinos postiže nešto kasnijom kosidbom. U cilju povećanja proteinske vrednosti vegetativne biomase, tritikale treba sejati sa nekom od zrnenih mahunarki, na primer sa stočnim graškom. Prednost tritikalea nad drugim pravim žitima je brži prolećni porast i mogućnost dužeg roka kosidbe za zelenu stočnu hranu jer kasnije ogrubi nego raž ili ovas. U Kanadi i SAD-u izvesne površine pod zimskim sortama tritikalea služe za obročnu ispašu domaćih životinja.

Tritikale pripada ugljenohidratnim, energetskim koncentrovanim hranivima. U novije vreme, pored kukuruza i zrno tritikalea predstavlja jedno od najvažnijih hraniva i izvora energije u ishrani domaćih i gajenih životinja u Srbiji. Zrno, kao i sporedni proizvodi dobijeni mlevenjem tritikalea, predstavljaju izuzetno pogodna visokosvarljiva hraniva za domaće i gajene životinje jer sadrže velike količine skroba, a relativno su siromašni u sirovim vlaknima. Proteine tritikalea, kao i ostalih zrna žita, preživari i nepreživari lako vare i apsorbuju. Koeficijent iskorišćenosti proteina tritikalea može biti veći nego kod drugih žita. Korišćenje tritikalea kao izvora energije u ishrani monogastričnih životinja često podrazumeva mogućnost smanjenja potrebne količine proteinskih hraniva u njihovoj ishrani. Mikrobna fermentacija skroba iz tritikalea u buragu preživara slična je kao kod ječma i ovsa, ali tritikale se bolje enzimski vari od drugih žita u pravom želucu preživara (*Fox* i sar, 2001).

Prosečan hemijski sastav zrna tritikalea prikazan je u tabeli 1, a uporedan hemijski sastav i energetska vrednost nekih zrna žita u Evropi u tabeli 2 (*De Boer andBichel*, 1988). Sastav i energetska vrednost pšenice, tritikalea i raži u Australiji uporedno su prikazani u tabeli 3 (*Edwards*, 1998), dok je uporedan hemijski sastav zrna tritikalea, pšenice i raži u Americi prikazan u tabeli 4 (*McGlone and Pond*, 2003).

Tabela 1. Prosečan hemijski sastav zrna tritikalea (% suve supstance)

Vrsta	Ukupni proteini	Skrob	Celuloza	Ukupni lipidi	Rastvorljivi šećeri	Mineralne soli
Tritikale	10,2 – 15,6	53 – 65	2,3 – 4,5	1,1 – 2,4	3,7 – 7,6	1,4 – 2,9

Tabela 2. Uporedan hemijski sastav i energetska vrednost tritikalea i drugih zrna žita u Evropi (g/kg suve materije)

Pokazatelj	Kukuruz	Pšenica	Tritikale	Raž	Ovas	Sirak	Proso
Ukupni proteini	106	130	140	116	120	120	128
Ukupna ulja	47	23	22	22	55	35	38
Celuloze	24	27	27	27	112	29	95
BEM	808	802	791	813	680	796	696
Skrob	700	680	620	640	440	700	590
Šećeri	20	31	55	50	18	15	10
Min. soli	15	18	20	22	33	20	43
Kalcijum	0,4	0,8	0,9	0,9	1,2	0,4	0,5
Fosfor	3,1	4,0	3,6	3,2	3,8	3,3	3,4
Sadržaj energije (MJ/kg suve supstance)							
ME, preživari	14,2	14	14	13,9	11,5	13,8	12,7
DE, svinje	16,4	16	15,8	15,7	13,2	15,8	13,6
AME, živina	15,9	14,8	14,5	12	12,3	15,3	14

Legenda: BEM – bezazotne ekstraktivne materije; ME – metabolička energija; DE – svarljiva energija; AME – prividna metabolička energija za živinu

Evropske sorte tritikalea imaju veći sadržaj ukupnih proteina i šećera u odnosu na druga ispitivana žita (*De Boer and Bichel*, 1988).

Tabela 3. Sastav i energetska vrednost pšenice, tritikalea i raži u Australiji (izraženo u suvoj materiji)

Vrsta žita	Pšenica	Tritikale	Raž
Svarljivi arabinoksilani (hemiceluloza) %	1.8	1.3	3.4
Nesvarljivi arabinoksilani (hemiceluloza), %	6.3	9.5	5.5
Beta glukani, %	0.8	1.7	2.0

Celuloza, %	2.0	2.5	1.5
Ukupno svarljivo, %	2.4	1.7	4.6
Ukupno nesvarljivo, %	9.0	14.6	8.6
Skrob, %	66 (54-74)	60 (55-63)	50
Protein, %	8-22	8-22	8-22
Metabolička energija, živina (MJ/kg)	9.0-14.8	14.0-15.2	(14.2)
Svarljiva energija, svinje (MJ/kg)	16.0	16.0	15.5
Metabolička energija, preživari (MJ/kg)	13.5	13.3	13.3

Tabela 4. Uporedan hemijski sastav zrna tritikalea, pšenice i raži u Americi (% u odnosu na masu svežeg i osušenog zrna)

Jedinjenja	Tritikale	Pšenica	Raž
Ukupni proteini	10,3-15,6	9,3-16,8	13,0-14,3
Skrob	57-65	61-66	54,5
Sirova vlakna	3,1-4,5	2,8-3,9	2,6
Rastvorljivi šećeri	3,7-5,2	2,6-3,0	5,0
Mineralne soli	1,4-2,0	1,3-2,0	2,1

Tritikale, kao i ostala zrnasta hraniva, standardni su deo obroka za ishranu domaćih i gajenih životinja, posebno u većem procentu kada je životinjama potrebno više energije. U zavisnosti od vrste domaće životinje kao i tipa obroka, tritikale može činiti njegov značajan procenat. Negde do sredine osamdesetih godina smatralo se da tritikale sadrži niz antinutritivnih jedinjenja koja smanjuju iskoristivost drugih hranljivih materija. Jedinjenja kao što su pentozani, pektini, tanini, beta glukani, prisutni su u tritikaleu, ali ne u tolikoj meri da bi došlo do poremećaja u sistemu varenja. Bez obzira na to, interesovanje za zrno tritikalea poraslo je zahvaljujući visokom sadržaju proteina i boljem sastavu aminokiselina u odnosu na druga žita koja se koriste u ishrani životinja (*Boros*, 2002).

S obzirom na to da tritikale sadrži više proteina u odnosu na ostala žita (tabela 2), ono se sve više koristi u obrocima domaćih životinja. Zrno tritikalea u pogledu zastupljenosti esencijalnih aminokiselina, pojedinih minerala i vitamina (tabela 5) može zadovoljiti značajan deo potreba domaćih i gajenih životinja (*Morey*,1983; *Macrae* i sar, 1993; *Lorenz* I sar, 1974; *Michela and Lorenz*, 1974; *Lebiedzinska and Szefer*, 2006; *Kowieska* i sar, 2011).

Tabela 5. Sadržaj esencijalnih aminokiselina, mineralnih materija i vitamina u tritikaleu

Aminokiseline (g/100g proteina)		Mineralni elementi		Vitamini	
Fenilalanin	4,08	K (%)	0,437	B_1 (tiamin)	0,34-0,38 mg
Histidin	1,87	P (%)	0,487	B_2 (riboflavin)	0,09-0,13 mg
Izoleucin	3,6	Mg (%)	0,190	B_3 (niacin)	16,2 17,9 µg
Leucin	6,5	Ca (%)	0,033	B_5 (pantoten. kiselina)	0,68-0,71 mg
Lizin	3,1	Fe p.p.m.	51,5	B_6 (piridoksin)	0,42-0,51 µg
Metionin	1,8	Mn p.p.m.	55,4	B_9 (folat)	78 µg
Treonin	3,2	Na p.p.m.	45	Provitamin A	0,015-0,017 mg
Triptofan	1,2	Cu p.p.m.	7,3	Vitamin E (tokoferol)	1,4 mg
Valin	4,5	Zn p.p.m.	26,1		

Zrno tritikalea se prvenstveno koristi za ishranu svinja, živine, raznih kaveznih ptica, ali i preživara, konja, glodara, kao i kućnih ljubimaca, te za biljojedne vrste riba u ribnjacima i za dohranu različitih vrsta divljači u lovištima za vreme zimskog perioda. Sastav aminokiselina u tritikaleu po nutricionističkim potrebama posebno odgovara monogastričnim životinjama, kao i živini (pticama). Neto iskorišćenost proteina kod ovih vrsta životinja može biti veća nego kod, na primer, pšenice i drugih žita, zahvaljujući visokom nivou aminokiseline lizina (*Belaid*, 1994; *Pfeiffer*, 1994; *Saade*, 1995; *Varughese* i sar, 1996b). Hemijska analiza zrna različitih novih, perspektivnih linija tritikalea se u CIMMYT centru koristi kao skrining metoda da bi se identifikovali genotipovi sa poželjnim nutricionističkim profilom za određenu životinjsku vrstu. Istraživanja su fokusirana na karakterizaciju hranljive vrednosti različitih genotipova tritikalea i izbor novih sorti sa poboljšanom biološkom vrednošću (na primer sa visokim sadržajem ukupnih proteina i metaboličke energije) za određenu životinjsku vrstu (*Mergoumand Gomez-Macpherson*, 2004). Današnje sorte tritikalea imaju više bioloških osobina pšenice nego raži zbog povratnih ukrštanja novostvorenih linija sa pšenicom. Morfološke osobine zrna su sve više kao u pšenice, uz neznatna variranja u masi 1.000 semena. Takođe, nove sorte tritikalea imaju veći sadržaj skroba u zrnu, a samim tim zrno je i energetski vrednije. Međutim, to je uslovilo smanjenje sadržaja ukupnih proteina u odnosu na starije sorte. I pored toga, količina i kvalitet ukupnih proteina u zrnu tritikalea su povoljniji za ishranu domaćih životinja nego u ostalih žita (*Varughese* i sar, 1996a; *Boros*, 2002; *Van Barneveld*, 2002). Zrno tritikalea je relativno meko, za razliku od tvrdozrnih sorti pšenice u kojih je ono skoro dvostruko tvrđe. To može biti prednost tokom prerade u stočnu hranu. *Van Barneveld* (2002) naglašava da meko zrno češće napadaju skladišne štetočine, tako da treba posvetiti punu pažnju čuvanju tokom skladištenja.

U mnogim zemljama u razvoju slama žita može biti značajan izvor hrane za neke životinje, posebno u sušnim godinama kada čak može imati veću vrednost od zrna (*Benbelkacem*, 1991; *Mergoum* i sar, 1992). Tritikale obično prevazilazi pšenicu, ječam i druga žita u količini dobijene slame, naročito u sušnim i polusušnim područjima (*Mergoum* i sar, 1992).

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Scientific criticism

THE IMPORTANCE OF TRITICALE IN ANIMAL NUTRITION*

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Abstract: Grains have great agronomic and economic importance and they are one of the most important plants. Triticale is modern cereal grain, hybrid of wheat and rye, which inherited the ability of the rye to survive the high frosts, but has a higher protein value than rye, while higher grain yields and increased tolerance to diseases were inherited from wheat. The way in which triticale will be used depends on the characteristics of the variety. Triticale varieties of large and uniform grains which have more proteins then starch are used as concentrated feed for poultry, ruminants and nonruminants. Varieties that form large biomass, similar to rye, can be and are grazed, or harvested for silage or hay and straw. Triticale grain has nutritional value like wheat but with slightly more lysine amino acid. Triticale as a feed grain with good essential amino acid balance, minerals and vitamins is primarily included in livestock diets especially as an energy source. Depending on the type of domestic animal and meal, triticale can be used in significant percentage. The advantage of triticale over other cereals is that it has higher yields, a faster spring growth, and a longer mowing time as a green animal feed, than for example rays or oats. Because of all these advantages, triticale is suitable for planting especially in developing countries.

Key words: triticale, animal nutrition, grain, chemical composition, nutritional value

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INTRODUCTION

One-year species of grass family (fam. Poaceae) cultivated for grains, but also several species from other botanical families whose fruits are used in a similar way are all classified into a group of grains. Grains with agronomic and economic importance are the most important group of grain plants. Of the relatively new "man-made" grain species, the most important is a hybrid of wheat and rye called triticale. Triticale has inherited the ability of the rye to survive strong frosts, but has a higher protein value (more gluten) (Amaya and Peña, 1991; Boros, 2002; Tikhnenko et al 2002; Chelkowski and Tyrka, 2003). From wheat it has inherited higher yields of grain and increased resistance to ergot.

ORIGIN OF TRITICALE

Triticale is the first successfully obtained grain that man created by crossing wheat (Triticum sp.) and rye (Secale cereale), two different types of grain. The first professional (scientific) name of the newly born species was Hexaploid triticale lat, and it was derived from the name of parental plants. According to Saprai et al, (1972), Scottish botanist Alexander Stephen Wilson (1827-1893) made the first cross between wheat and rye in 1875. This plant never produced fertile hybrid offspring because its parent species didn't have the same number of chromosomes.

Despite this lack, the initial results were interesting for science. After that, a large number of scientists from the field of biological sciences worked on the crossing of different varieties of wheat and rye in order to obtain the best hybrids. According to the scientists' vision, triticale should have had the best traits of both parents, the bread-baking quality of wheat grains and excellent adaptability of rye to different agroecological and soil conditions, as well as increased tolerance to pests and pathogens. A new type of grains should have been cultivated with less investment in production technology and would have been suitable for growing in developing countries with the aim of providing larger amounts of basic food for the population. However, modest knowledge in the field of genetics did not provide an answer to solve the problem that arises by crossing different species and as a consequence has a sterile F1 generation (Laibach, 1925). Nevertheless, the expectations of the global public and forecasts were that the newly created grain, thanks to its high fertility potential, would significantly increase food production, both in underdeveloped and developed countries. The famous Swedish geneticist Arne Müntzing (Müntzing, 1979) wrote that it should be expected that the synthetic species of triticale will join the old grains as food for a significantly larger number of human population and their domestic animals. Based on its morphological and production traits, this species can have higher yields from parent species, especially in less favorable agroecological conditions and on poorer lands.

The First World War interrupted the work on triticale selection in Europe, but it was continued on the American continent. The International Center for the Improvement of Maize and Wheat (Centro Internacional de Mejoramiento de Maiz y Trigo CIMMYT) was established in Mexico. Using the most modern genetic methods, the first problem of poor fertility of the new hybrid was solved. The second step was to increase the quality of grain for human consumption (improved bread-baking properties) and domestic animals consumption (increased content of digestible proteins). By creating winter varieties of high and solid stems with an increased coefficient of productive branching ,triticale becomes a very important fodder plant whose biomass is used in the feeding of ruminants as fresh or for storing hay or silage. Some varieties can be used in combination – by grazing and mowing. As fodder , triticale is most commonly grown on the American continent, while in developing countries grains are produced for human consumption (Glamoclia and sar, 2017). Thanks to this scientific center, work on breeding has been consolidated and the results obtained regarding the creation of new triticale genotypes are available to all interested selectors and manufacturers. Since the beginning of work in CIMMYT, more than 200 varieties of triticale have been created and can be used in different ways (Glamoclia et al, 2017). Today, this Center has research stations in more than 30 countries around the world.

Work on triticale selection in Europe was continued between the two World Wars. Blakeslee and Avery (1937) noted that cross-breeding of wheat as mother plants and rye as pollen donors most often resulted in sterile hybrids. However, when treatment with colchicine induced polyploidy, they concluded that this chemical doubled the number of chromosomes and produced fertile progeny. Based on this knowledge, in 1937, scientist Pierre Civaudron in France perfected the technique of obtaining fertile progeny by crossing wheat and rye. By applying new selection methods, he created a large number of commercial species with good production qualities.

In Serbia, the production of new triticale genotypes, interesting for commercial production, has a decades-long tradition. Our scientists have identified this new species as grain that can be used for human and domestic animals nutrition, as well as in industrial processing. Triticale breeding in our country is done by the institutes, which have provided big banks of genes, or lines of triticale from abroad and from their own crossings (Glamoclia et al, 2013).

THE ECONOMIC CHARACTER OF TRITICALE

The way in which triticale will be used depends on the characteristics of the species, or to which of the parents it is more similar. Boros (2002) points out that the species of large and same quality grains, which are by chemical composition closer to wheat, are used in human and animal nutrition. Species with large biomass serve to store fodder. Species of large grains with increased total protein content compared to starch are used for the preparation of concentrated animal feed, both for poultry, as well as for nonruminants and ruminants (Belaid, 1994; Myer, 2002; Đekić i sar, 2009). The importance of triticale in direct human nutrition or indirectly, as fodder, is great. However, world production of triticale and other grains is not in proportion to the increase in the number of people. The data indicate that in the last few years the total grain production in the world was less than the average, which can globally cause hunger (Glamoclia and sar, 2017). Cereal production per capita in 2012, due to droughts in Australia and the United States amounted to 294 kg and was the smallest in the past 30 years. Blum (2014) emphasizes that one of the solutions is to increase the area under triticale due to the fact that this plant can grow on marginal lands, as well as in arid conditions that are becoming more and more widespread as a result of global climate change. Newer generation of triticale species has significantly improved biological properties and higher quality grains due to increased protein content, especially lysine. These species provide the possibility for wider use in human nutrition, for example, for baking bread mixed with wheat flour, but also for feeding domestic animals by preparation of concentrated feeds of increased nutritional value (Baier and Gustafson, 1996; Aguirre et al., 2002).

THE IMPORTANCE OF TRITICALE IN ANIMAL NUTRITION

Triticale is used in the diet of domestic and farm animals in many ways. Grains, thanks to the high content of total proteins and carbohydrates, serve to prepare concentrated animal feed (Lorenz, 2003). In the diet of domestic animals, it can replace oats, fodder barley and other cereals. Comparing with the chaff of barley and oats, the grain is far more suitable as concentrated food for poultry and nonruminants due to the higher coefficient of food utilization (Đekić et al, 2009).

Aboveground biomass is used as voluminous food for ruminants. In that case, triticale is cultivated as pure crop, but it can also be sown in various mixtures with winter and spring legumes (Poysa, 1985; Blade et al., 2002; Schwarte et al., 2005). The produced biomass is used fresh or for storing silage or hay. Aboveground biomass of triticale, grown in pure crop or in mixtures, is also used through grazing , most commonly through pasture (Redmon et al., 1995).

The nutritional value of the grain is as the one of wheat, with slightly more amino acid lysine. Based on current knowledge on triticale grains used in the production of concentrated animal feeds, the best results are achieved in the feeding of poultry (turkeys and chickens) and dairy cattle. As a forage plant, triticale has a higher yield than other real cereals. The highest quality biomass is obtained by mowing the plants at the beginning of ear formation while the highest yield is achieved by a later mowing. In order to increase the protein value of vegetative biomass, triticale should be sown with some of the grain legumes, for example with field pea. The advantage of triticale over other real cereals is a faster spring rise and the possibility of a longer mowing time for green feed, as it grinds later than rye or oats. In Canada and the USA, certain areas under winter species of triticale serve as pasture for domestic animals.

Triticale belongs to carbohydrate, energy-concentrated nutrients. In recent times, beside maize it is one of the most important nutrients and sources of energy in the nutrition of domestic and farmed animals in Serbia. Grains, as well as by-products obtained by treating triticale, are extremely suitable highly digestible nutrients for domestic and farmed animals because they contain large quantities of starch, and are relatively poor in raw fibers. Ruminants and nonruminants easily digest and absorb triticale protein, as well as other grain cereals .Triticale protein utilization coefficient may be higher than in other cereals. The use of triticale as a source of energy in the diet of monogastric animals often implies the possibility of reducing the needed amount of protein nutrients in their diet. Microbial fermentation of starch from triticalea in ruminants' rumen is similar to that of barley and oats, but triticale is better digested enzymatically than other cereals in ruminants' stomach (Fox i sar, 2001).

The average chemical composition of triticale grains is shown in Table 1, the comparative chemical composition and energy value of some wheat grains in Europe is shown in Table 2 (De Boer andBichel, 1988). The composition and energy value of wheat, triticale and rye in Australia are shown in Table 3 (Edwards, 1998), while the comparative chemical composition of grains of triticale, wheat and rye in America is shown in Table 4 (McGlone and Pond, 2003).

Table 1. Average chemical composition of triticale grains (% of dry matter)

Species	Total protein	Starch	Cellulose	Total lipids	Soluable sugars	Mineral salts
Triticale	10,2-15,6	53-65	2,3-4,5	1,1-2,4	3,7-7,6	1,4-2,9

Table 2. Comparative chemical composition and energy value of triticale and other grains in Europe (g / kg of dry matter)

Indicator	Corn	Wheat	Triticale	Rye	Oat	Millet	Proso
Total proteins	106	130	140	116	120	120	128
Total oils	47	23	22	22	55	35	38
Cellulose	24	27	27	27	112	29	95
BEM	808	802	791	813	680	796	696
Strach	700	680	620	640	440	700	590
Sugars	20	31	55	50	18	15	10
Min.salts	15	18	20	22	33	20	43
Calcium	0,4	0,8	0,9	0,9	1,2	0,4	0,5
Phosphorus	3,1	4,0	3,6	3,2	3,8	3,3	3,4
Energy content (MJ/kg of dry supstance)							
ME, ruminants	14,2	14	14	13,9	11,5	13,8	12,7
DE, pigs	16,4	16	15,8	15,7	13,2	15,8	13,6
AME, poultry	15,9	14,8	14,5	12	12,3	15,3	14

BEM-non-essential extractive matter ; ME-metabolizable energy; DE-digestible energy; AME – apparent metabolizable energy for poultry

European species of triticale have higher total protein and sugar content compared to other examined cereals (De Boer and Bichel, 1988).

Table 3. Composition and energy value of wheat, triticale and rye in Australia (expressed in dry matter)

Grain type	Wheat	Triticale	Rye
Digestible arabinoxylans (hemicellulose) %	1.8	1.3	3.4
Nondigestible arabinoxylans (hemicellulose %	6.3	9.5	5.5
Beta glucans, %	0.8	1.7	2.0
Cellulose, %	2.0	2.5	1.5
Total digestible, %	2.4	1.7	4.6
Totalnondigestible, %	9.0	14.6	8.6

Starch, %	66 (54-74)	60 (55-63)	50
Proteins, %	8-22	8-22	8-22
Metabolizable energy, poultry (MJ/kg)	9.0-14.8	14.0-15.2	(14.2)
Digestible energy, pigs (MJ/kg)	16.0	16.0	15.5
Metabolizable energy, ruminants (MJ/kg)	13.5	13.3	13.3

Table 4. Comparative chemical composition of grains of triticale, wheat and rye in America (% regarding the mass of fresh and dried grains)

Compounds	Triticale	Wheat	Rye
Total proteins	10,3-15,6	9,3-16,8	13,0-14,3
Starch	57-65	61-66	54,5
Raw fibers	3,1-4,5	2,8-3,9	2,6
Soluble sugars	3,7-5,2	2,6-3,0	5,0
Mineral salts	1,4-2,0	1,3-2,0	2,1

Triticale, like other grain feeds, is standard part of the meal for domestic and farmed animals, especially when animals need more energy. Depending on the type of domestic animal and the type of meal, triticale can make a significant percentage. By the mid-1980s, triticals were thought to contain a number of antinutritive compounds that reduce the usefulness of other nutrients. Compounds such as pentosans, pectins, tannins, beta glucans are present in triticale, but not to the extent which causes disorders in the digestion system. Nevertheless, the interest in triticale grains has increased due to the high protein content and better composition of amino acids compared to other cereals used in animal nutrition (Boros, 2002).

Since triticale contains more proteins compared to other cereals (Table 2), it is increasingly used in domestic animal feeds. Triticale grains, in terms of the presence of essential amino acids, certain minerals and vitamins (Table 5) , can satisfy a significant proportion of domestic and farmed animals’ needs (Morey, 1983; Macrae et al, 1993; Lorenz et al, 1974; Michela and Lorenz, 1974; Lebedzinska and Szefer, 2006; Kowieska et al, 2011).

Table 5. Content of essential amino acids, minerals and vitamins in triticale

Amino acids (g/100g proteina)		Minerals		Vitamins	
Phenylalanine	4,08	K (%)	0,437	B_1 (thiamine)	0,34-0,38 mg
Histidine	1,87	P (%)	0,487	B_2 (riboflavin)	0,09-0,13 mg
Isoleucine	3,6	Mg (%)	0,190	B_3 (niacin)	16,2 17,9 µg
Leucine	6,5	Ca (%)	0,033	B_5(pantothenic acid)	0,68-0,71 mg
Lysine	3,1	Fe p.p.m.	51,5	B_6 (pyridoxine)	0,42-0,51 µg
Methionine	1,8	Mn p.p.m.	55,4	B_9 (folate)	78 µg
Treonine	3,2	Na p.p.m.	45	Provitamin A	0,015-0,017 mg
Triptophan	1,2	Cu p.p.m.	7,3	VitaminE (tocopherol)	1,4 mg
Valin	4,5	Zn p.p.m.	26,1		

The grain of triticale is primarily used for the feeding of pigs, poultry, various caged birds, but also of ruminants, horses, rodents, and pets. It is also used for feeding herbivorous fish in fishponds and as supplementary feeding of various game species in hunting grounds during the winter period. The composition of amino acids in triticale regarding nutritional needs is particularly suited to monogastric animals, as well as poultry (birds). Net protein utilization in these animal species can be higher than that one from wheat and other cereals due to high levels of lysine amino acid (Belaid, 1994; Pfeiffer, 1994; Saade, 1995; Varughese et al 1996b). Chemical grain analysis of various new, promising lines of triticale is used in the CIMMYT centre as a screening method to identify genotypes with a preferred nutritional profile for a particular animal species. Research has been focused on the characterization of the nutritional value of various triticale genotypes and the selection of new varieties with improved biological value (for example, high protein content and metabolizable energy) for a particular animal species (Mergoumand Gomez-Macpherson, 2004). Today's varieties of triticale have more biological characteristics of wheat than rye due to backcrossing of newly created lines with wheat. Morphological properties of grains are more like these of wheat, with a slight variation in the mass of 1,000 seeds. Also, new varieties of triticale have higher starch content in grains, hence the grain is more energy-efficient. However, this has led to a decrease in the total protein content compared to older varieties. Still, the amount and quality of total proteins in triticale grains are more favorable for feeding domestic animals than in other cereals (Varughese et al., 1996a; Boros, 2002; Van Barneveld, 2002). The grain of triticale is relatively soft, as opposed to hard species of wheat which is almost twice as firm. This can be an advantage in fodder processing. Van Barneveld (2002) emphasizes that soft grains are often attacked by storage pests so that full attention is to be paid to maintenance during storage.

In many developing countries, straw can be an important source of food for some animals, especially in droughty years when it can even have a higher value than grain (Benbelkacem, 1991; Mergoum et al., 1992). Triticale usually exceeds wheat, barley and other cereals in the amount of straw produced, especially in dry and semi-dry areas (Mergoum et al., 1992).

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