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FORAGE NUTRITIVE VALUE OF SOYBEAN VARIETIES

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ABSTRACT

This study was carried out in Bingol Province of Turkey in the growing season of 2012 to determine the nutritive value of different soybean varieties. A total of 12 different soybean [*Glycine max* (L.) Merr.] varieties supplied from Eastern Mediterranean Agricultural Research Institute, Western Mediterranean Agricultural Research Institute, Aegean Agricultural Research Institute and May-Agro Seed Company were used as the plant material of the field experiments. Experiments were carried out in randomized block design with 3 replications. Green herbage and hay yields, crude protein (CP), protein yield (PY), crude ash (CA), dry matter digestibility (DMD), dry matter intake (DMI), relative food value (RFV), acid detergent fiber (ADF) and neutral detergent fiber (NDF) characteristics were investigated. The results showed that the varieties Blaze, Ataem-7, Cinsoy, Nova, Erensoy and Türksoy were considered as primary varieties to be used in animal feed and agricultural activities of the region with regard to hay yield and quality.

Key words: Ash, ADF, Green herbage yield, Hay yield, NDF, Protein, Soybean variety.

INTRODUCTION

Soybean is a legume and can make good feed. Nutritive value of a soybean plant can be comparable to early-bloom alfalfa. Lactating dairy cows and growing heifers have similar performance when given either soybean hay or alfalfa forage (Garcia, 2006).

The importance of soybean as a protein supplement for animal feed and its potential value for human food is well recognized (Kakade *et al.*, 1972). Livestock producers need high-protein summer forage. Forage soybeans fit well in a production system following small grains or early planted corn. Soybean [*Glycine max* (L.) Merr.] can be a high-quality alternative forage, but little is known about the influence of management practices on partitioning and composition of soybean plant components, and therefore on whole-plant forage quality (Hintz and Albrecht, 1994).

Soybean plants may be grazed or harvested from the flowering stage to near maturity for use as high-quality hay. Soybeans may also be grown as a silage crop in pure culture or intercropped with corn or sorghum. Using soybeans for forage, rather than grain, is also economically feasible given the current relative values (Blount *et al.*, 2009).

Unlike most legume crops used for hay, both foliage and pods in soybean provide digestible protein. The soybean plant, when harvested just prior to leaf yellowing at maturity, contain pods that are high in protein and oil. The quality of forage soybean varies depending on the variety, stage of growth, age, and harvesting losses. From the standpoint of producing the highest quantity and quality of forage, the best time to cut is at 90 percent pod fill, just before the leaves begin to yellow and fall. One of the main advantages of soybean forage is the flexibility of harvest dates, since its quality is good over a long period (Blount *et al.*, 2009).

Objective of this study is to determine the nutritive value of different soybean varieties which can be used in animal feed in Turkey.

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MATERIALS AND METHODS

In this research, soybean varieties of Nazlican, Türksoy, Adasoy, Yemsoy and Yesilsoy from Eastern Mediterranean Agricultural Research Institute, Ataem-7 and Erensoy from Western Mediterranean Agricultural Research Institute, Cinsoy and Umut-2002 from Aegean Agricultural Research Institute and Blaze, Nova and May-5312 from May-Agro Seed Company were used as the material.

The study area has a typical terrestrial climate. According to the long term averages, the coolest month is January with a monthly mean temperature of -13.9°C and the hottest month July with 38.6 °C. During the course of the study, they in turn became -8.7 °C in February and 35.1 °C in August. Long-term total yearly precipitation received is 962.8 mm in the area. There was more total precipitation (1073.7 mm) in 2012 than the long term average. However, less precipitation (77.8 mm) in the vegetative growth period of 2012 was recorded than the long term average (123.1 mm). According to the average climatic data in the growing season of 2012 obtained from the Meteorological Station of Bingol, the dry period for the study area is from May to October.

Soils of the experimental areas have a variable topography from almost flat to gentle slopes with clay texture. The soils in Bingol were slightly alkaline (pH 7.8), high in calcium carbonate (8.66%), low in organic matter (0.63%), low in phosphorus (14.9 kg ha^{-1} P_2O_5), high in potassium (330 kg ha^{-1} K_2O), very high in iron (6.46 ppm) and medium in copper (1.49 ppm), manganese (2.14 ppm) and zinc (1.52 ppm) (Anonymous, 2012).

Experiments were carried out in experimental fields of a farmer's field in Bingol during the growing season of the year 2012. Field experiments were implemented in randomized block design with 3 replications. Soybeans were sown in the first week of May and harvested at the full seed stage. Experimental plots were designed at 4x2.8 m with 4 rows. Row spacing was 70 cm and on-row plant spacing was average 5 cm. Samples harvested at the full seed stage were weighed for green herbage yield and were dried at 70°C in a drying cabin (Memmert ULM 800) for 24 hours for hay yield.

Dry samples were milled through 1 mm sieve and used for analysis. Crude ash content of samples was determined by burning at 550 °C for 8 hours. Kjeldahl method was used to determine the nitrogen (N) content of dried samples taken from the plots. Crude protein was calculated by using the equation of Nx6.25 (AOAC, 1990). NDF was determined in accordance with Van Soest and Wine (1967) and ADF in accordance with Van Soest (1963) by using ANKOM 200 Fiber Analyzer (ANKOM Technology Corp. Fairport, NY, USA). Samples were grinded and sieved through 1 mm sieve. A 0.5 g sample was placed into filter bags and boiled in ADF solution at ANKOM device for an hour. Non-dissolved portion was then dried at 105 °C for 4 hours and weighed to determine ADF content. Same processes were repeated for NDF content just by replacing ADF solution with NDF solution.

Digestible Dry Matter (DDM), Dry Matter Intake (DMI) and Relative Feed Value (RFV) were calculated by using following equations (Morrison, 2003):

$$DDM = 88.9 - (0.779 \times ADF)$$
$$DMI = 120 \div NDF$$
$$RFV = (DDM \times DMI) \div 1.29$$

Variance analysis of experimental results was carried out by using SAS (SAS Inst., 1999) software. LSD test was used to evaluate the significance of differences among the averages.

RESULTS AND DISCUSSION

Chemical compositions and protein yield of the soybean varieties are given in Table 1. There were significant differences among soybean varieties in the chemical composition and protein yield. The NDF and ADF levels ranged between 48.5 to 54.9% and 33.3 to 44.1%, respectively. The highest NDF was obtained from Erensoy variety, while the lowest NDF was obtained from Ataem-7 and May-5312 varieties. The highest ADF was obtained from Yesilsoy variety, while the lowest ADF was obtained from Nova variety. The ADF and NDF are similar to values reported by Smith *et al.* (1981), Undersander (1999), Robinson *et al.* (2001), Brown (2003) and Blount *et al.* (2009). But NDF is lower than those reported by Albro *et al.* (1993), Mertens (1997), Bodine *et al.* (2000) and Sheaffer *et al.* (2001). In general, the fiber content was within the range

TABLE 1: Chemical compositions and protein yield of soybean varieties.

Varieties	NDF (%)	ADF (%)	CP (%)	Ash (%)	Protein Yield (kg/da)
Yesilsoy	52.5 a-c	44.1 a	12.3 ab	7.89 bc	44.6 de
Adasoy	49.9 dc	37.1 c	12.4 ab	7.39 bc	38.7 e
Türksoy	51.4 a-d	41.1 b	11.5 ab	7.46 bc	52.3 a-d
Erensoy	54.9 a	38.1 c	10.8 b	7.99 bc	52.5 a-d
Yemsoy	50.2 b-d	41.6 b	11.1 b	7.16 c	44.6 de
Blaze	50.1 b-d	37.2 c	12.5 ab	10.13 a	61.8 a
May 5312	48.7 d	36.8 c	12.1 ab	8.62 bc	49.0 b-e
Nazlican	51.9 a-d	42.0 b	10.8 b	8.50 bc	47.0 c-e
Nova	49.6 cd	33.3 d	12.2 ab	8.45 bc	56.3 a-c
Cinsoy	48.6 d	38.1 c	12.4 ab	8.86 ab	58.6 ab
Umut 2002	53.6 ab	40.4 b	12.8 a	8.16 bc	46.3 c-e
Ataem 7	48.5 d	37.6 c	13.2 a	8.39 bc	58.7 ab
Average	50.8	38.9	12.0	8.25	50.9
Sig.	*	**	*	*	**

* P< 0.05, ** P< 0.01, statistically important.

reported for forages such as alfalfa (Julier *et al.*, 1999; Robinson *et al.*, 1999) rather than high fat concentrate ingredients. With regard to ADF and NDF ratios, while the values were similar to the values of *Medicago sativa* and *Onobrychis sativa***,** they were lower than the values of *Vicia sativa* and *Lathyrus sativus* (Kaplan, 2011; Basaran *et al.*, 2011; Canpolat *et al.*, 2013; Kaplan, 2013).

The CP contents ranged between 10.8 to 13.2%. The highest CP content was obtained from Umut-2002 and Ataem-7 varieties, while the lowest CP content was obtained from Erensoy, Nazlican and Yemsoy varieties. The results of CP are similar to values reported by Martin *et al.* (1997) and Wanapat *et al.* (2007). But it is lower than those reported by Undersander (1999), Brown (2003) and Blount *et al.* (2009). The reason for this is due to the soil and climate change. Soybean forage, when harvested at the full seed stage of development (Fehr and Caviness, 1980) is comparable to that of alfalfa, both in quality and quantity (Hintz and Albretcht, 1994), since a well established variety can produce between 12% and 20% of protein. The interactions between the genotype, the maturity stage of the plants at harvest and environmental factors were determined (Cummins, 1981 and Filya, 2004). So, in the present study, significant interaction was observed between the soybean varieties. Tobia *et al.* (2008) reported that average CP content of the soybean forage was 20.2% DM, which is significantly higher than that produced by tropical grasses. Crude protein ratios of soybean were similar to ratios of *Vicia sativa* and *Onobrychis sativa* and lower than the ratios of *Medicago sativa* and *Lathyrus sativus* (Rahmati *et al.*, 2012; Kaplan, 2011; Basaran *et al.*, 2011; Kanani *et al.*, 2006).

The ash rates ranged between 7.16 to 10.13%. The highest ash rate was obtained from Blaze variety, while the lowest ash rate was obtained from Yemsoy variety. The results of ash rate were similar to values reported by Albro *et al.* (1993). But it is higher than those reported by Polat (1998) and Wanapat *et al.* (2007). ash concentration varies with soil fertility, fertilizer application, soil pH, and other soil and climatic variables (Tobia *et al.*, 2008), but average ash concentration of forage observed in soybean with 8.25% (Table 1) was quite similar to that found in alfalfa (Broderick *et al.*, 2002). Crude ash contents were mostly similar to values of other forage crops (Kaplan, 2011; Basaran *et al.*, 2011; Canpolat *et al.*, 2013; Kaplan, 2013). The protein yield ranged between 38.7 to 61.8 kg/da. The highest protein yield was obtained from Adasoy variety, while the lowest protein yield was obtained from Blaze variety.

Green herbage and hay yield, dry matter digestibility (DMD), dry matter intake (DMI) and relative food value (RFV) of the soybean varieties are given in Table 2. There were significant differences among soybean varieties in the green herbage and hay yield, dry matter digestibility, dry matter intake and relative food value. The green herbage yields ranged between 1204.7 to 1652.7 kg/da. The highest green herbage yield was obtained from Erensoy variety, while the lowest green herbage

TABLE 2: Green herbage and hay yield, dry matter digestibility (DMD), dry matter intake (DMI) and relative food value (RFV) of soybean varieties.

Varieties	Green Herbage Yield (kg/da)	Hay Yield (kg/da)	DMD (%)	DMI	RFV
Yesilsoy	1289.0 cd	566.0 cd	54.6 d	2.28 b-d	96.6 c
Adasoy	1255.3 d	524.6 d	60.0 b	2.41 a-c	111.9 ab
Türksoy	1474.3 bc	703.1 a	56.9 c	2.34 a-d	103.2 c
Erensoy	1652.7 a	653.9 ab	59.3 b	2.19 d	100.6 c
Yemsoy	1514.3 ab	622.1 a-c	56.5 c	2.40 a-c	105.1 bc
Blaze	1265.d	611.8 bc	59.9 b	2.40 a-c	111.5 ab
May 5312	1204.7 d	569.1 cd	60.2 b	2.46 a	115.0 a
Nazlican	1453.0 bc	556.7 cd	56.2 c	2.32 a-d	100.9 c
Nova	1228.7 d	667.6 ab	62.9 a	2.42 ab	118.2 a
Cinsoy	1226.7 d	660.4 ab	59.2 b	2.47 a	113.3 ab
Umut 2002	1332.7 b-d	565.7 cd	57.5 c	2.24 cd	99.7 c
Ataem 7	1365.0 b-d	697.7 ab	59.6 b	2.48 a	114.3 a
Average	1355.2	616.6	58.6	2.37	107.5
Sig.	**	**	**	*	**

* P< 0.05, ** P< 0.01, statistically important.

yield was obtained from Blaze, Adasoy, Nova, Cinsoy and May-5312 varieties. The results of green herbage yield are similar to reported by Martin *et al.* (1997), Undersander (1999) and Brown (2003). The hay yields ranged between 524.6 to 703.1 kg/da. The highest hay yield was obtained from Türksoy variety, while the lowest hay yield was obtained from Adasoy variety. The results of this study of hay yield were considerably lower than that obtained by Undersander (1999) and Blount *et al.* (2009). This might be due to genotypic factors and differences in growth site. Compared to other common forage legumes, while hay yield of soybean was lower than the yields of *Medicago sativa*, (Saruhan and Kusvuran, 2011) and *Onobrychis sativa*, green herbage yield was lower but dry hay yield was similar with *Vicia sativa* and *Lathyrus sativus* (Kaplan, 2013; Karadag *et al.*, 2012). Despite the superiorities and deficiencies compared to other forage legumes, soybean may reliably be included into crop rotations as a forage crop since it can be sown as the first or second crop, it can enrich the organic matter content of soils and it is highly nutritious.

The DMD ranged between 54.6 to 62.9%. The highest DMD was obtained from Nova variety, while the lowest DMD was obtained from Yesilsoy variety. The results of DMD are similar to values reported by Albro *et al.* (1993). The DMI ranged between 2.19 to 2.48. The highest DMI was obtained from May-5312, Cinsoy and Ataem-7 varieties, while the lowest DMI was obtained from Erensoy variety. The results of DMI are higher than those reported by Albro *et al.* (1993) and Wanapat *et al.* (2007). Voluntary intake of feed can be influenced by N in the diet (Van Soest, 1982). The RFV ranged between 96.6 to 118.2. The highest RFV was obtained from Ataem-7, May-5312 and Nova varieties, while the lowest RFV was obtained from Yesilsoy, Umut-2002, Erensoy, Nazlican and Türksoy varieties. Soybean forage can be produced even in the wet tropics at a much lower cost than soybean grain, because it does not requires a dry season coincident with time of neither seed ripening nor any expensive harvesting machinery (Tobía and Villalobos, 2004).

CONCLUSION

The soybean may be grown as annual hay or as a pasture crop; it may be ensiled or fed green. The soybean is one of the few annual legumes suitable for the production of hay, and can therefore substitute for this purpose in the event of an alfalfa failure. Within three to four months after seeding it produces hay equal in quality to alfalfa hay. It is usually recommended to feed it with other kinds of hay. One of the main advantages of soybean forage is the flexibility of harvest dates, since its quality is good over a long period. In production of soybean hay there is a trade-off between tonnage and the speed at which the hay dries.

The twelve soybean varieties examined were different in nutrient levels. The study suggested that the varieties Blaze, Ataem-7, Cinsoy, Nova, Erensoy and Türksoy (for hay and protein yield) can recommend to the farmers.

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