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Productivity And Chemical Composition Of Several Mulberry Species (*Morus spp*) Agains Spacing Plant, and Cutting Age

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Abstract

The cultivation of mulberry as forages is scarce in Indonesian feeding system for ruminant production, although many studies have indicated its nutritional potential as animal feed especially ruminants. This study was aimed to investigate the effects spacing of plant and cutting age on productivity and chemical composition of some species mulberry plants. The experiment was conducted in a randomized block design with factorial treatments. The factors species were (*M. indica cv kanva, M. nigra, M. cathyana, and M. Multicaulis*), the spacing of plants (1 x 0.5 m, 1 x 1 m and 1 x 1.5 m) and cutting ages (210, 240, and 270 days after planting). The results showed that species, *M. multicaulis* and *M. cathyana* are the highest growth, using a spacing of 1 x 0.5 m with cutting age 270 days after planting. Dry matter production highest ($P < 0,05$) in *M. Cathyana* at spacing of 1 x 0.5 with cutting age 270 days after planting. The ratio of leaves and stems of plants are affected by age, the highest proportions of leaf is obtained at the cutting age of 210 days. Chemical composition were highest in *M.multicaulis* at the age of 270 days. The highest content of organic matter (OM) were found in *M.Kanva* and not different with *M. Nigra* at the age of 270 day after planting. In treatment of cutting ages have no effect ($P < 0.05$) on the Crude protein (CP), ADF, NDF, lignin and tannin content. The average content of CP obtained gained 20.69%, 32.38% ADF, NDF 33.99%, 12.45% lignin and tannin 0.3%. Concluded that mulberry plants with a plant spacing of plant 1 x 0.5 and 270 days after plant have more advantages for use as animal feed.

Key words : Mulberry, production, chemical compositions

Background

Mulberry (*Morus spp*) Is one type of forage that can be used as animal feed protein source (Ondiek *et al*., 2000; Miller *et al*., 2005). Mulberry plants belonging to the genus Morus, family Moraceae and Ordo Dicotyledonae. It is estimated that there are 68 species of the genus Morus spread across Asia (Datta, 2001), and in China there are more than 1000 varieties (Sanchez, 2000). Some species such as *Morus indica* (white mulberry), *Morus nigra* (black mulberry), *Morus cathyana, Morus multicaulis, Morus rubra* (red mulberry) has spread and adapt well in the tropics and sub tropics ranging from altitude 0-4000 m asl. Mulberry cultivation has grown as a source of feed silkworms for silk textile interests. The crude protein (CP) content of mulberry can reach 24.9% (Saddul et al., 2004) with a digestibility level of between 75-85% (Nguyen Xuan Ba *et al*., 2003; Nguyen Xuan Ba *et al*., 2004). The crude protein content is comparable to some plant species of legume trees that ranged from 20-28% (Khaito *et al*., 1997). Mulberry can be used as a substitute supplement concentrate up to 75% without affecting to the production and quality of milk (Yulistiani, 2008).

Mulberry can be used as a protein supplement throughout the year (Sanchez, 2001), then this plant is one of alternative feed sources of potential to be developed optimally. Some important factors that improve development and production of mulberry plants is a spacing of plant and cutting age (Almaida and Fonseca, 2002). It is known that the productivity and nutritional quality of forage is influenced by age (growing phase) as well as the composition of the fractions plants, such as the ratio of leaves / stems. In addition, the frequency of cuts can affect the production of dry matter, morphological composition,

nutritional composition and digestibility of the feed (Kabi and Bareeba, 2008). There fore, defoliation management information concerning spacing of plant and cutting age are important in managing the plant and the production of feed to produce optimal nutritional quality, when used as forage. This study aims to determine the agronomic characteristics (plant height growth, productivity, the ratio of leaf / stem), as well as some of the nutritional composition mulberry agains of spacing plant and cutting age.

Materials and Methods

The research was done in the experiment forage and loboratory of animal feed and nutrition Indonesia goat research station, Sungei putih North Sumatera. The located at an altitude of ± 50 m from sea level, with the soil type podsolid (red sand) with an average rainfall of 1800 mm/year. The material used in this study are four species of mulberry seeds originating from the collection of forages in Indonesia goat research station.

Preparation of cultivation was done with land clearing, spraying herbicides, hoe with tractors. Nursery plants derived from stem mulberry tree that is quite old with a cutting height of 0.5 meters from the ground. Pieces cuttings each branch length of 15-20 cm or have 3 buds with a diameter of 1-3 cm. The selection of the seeds are good and healthy cuttings (stem shiny, not damaged (deformed), does not rot and protected from disease borer). Cuttings planted in polybag and placed in the area who have given shade paranet with light intensity of approximately 50%. The plants treated with weeding and watering every day until 2 months old. Then plants were transferred to a plot in accordance with the treatment that has been set with a spacing of 1x0,5m, 1x1m, 1x1,5m. Treatment is done until the time of harvest for the provision of basic fertilizer (manure) 4 tons / ha, chalk as much as 10 tonnes / ha and chemical fertilizers such as urea (300 kg / ha), TSP (400 kg / ha) and KCL (200 kg / ha).

Mulberry harvested at 210, 240, and 270 after planting with cutting height of 100 cm above the ground. Yields were weighed and then the separation between the leaves and stems fractions to determine the biomass production and the ratio of leaves / stems. To obtain a dry matter (DM), samples were taken of 500 g then dried at a temperature of 65^0C for 72 hours in the oven, then using a grinder (hummer mill) with a filter diameter of 1.0 mm. Samples were analyzed in the laboratory to determine the content of crude protein (CP) with the detruksi method test auto-analysis of AOAC (2005), ADF (acid detergent fiber), NDF (neutral detergent fiber), lignin (gravimetric methods) and tannins (spectrophotometry method). A proportion of samples entered in the electric furnace at a temperature of 600^0C for 8 hours, and then weighed to determine the organic material (OM) with the gravimetric method.

The study was conducted in a randomized block design faktorial pattern, consisting of 3 factors. The first factor are species of mulberry (*Morus indica cv Canva, Morus nigra, Morus cathyana,* and *Morus multicaulis*). The second factor are spacing of plant (1 x 0.5 m, 1 x 1 m and 1 x 1.5 m) and the third factor cutting ages (210, 240, and 270 after plant). Consists of 3 replication. Data was analyzed using ANOVA method, and if there is a significant difference ($P < 0.05$) followed by Duncan's multiple range test, (DMRT).

Results and Discussion

High Growth of Plant

From the result of observation, the longer cutting age it is plants grow higher. Winata *et al*. (2012) indicates that the higher plant have greater production obtained. Data obtained from the results of this study indicate that the species *M. multicaulis* is the tallest plants, not different with *M. Cathyana*. The growth is strongly influenced by the spacing of the 1 x 0.5 and 1 x 1cm and the cutting age of 210, 240 and 270 days. Spacing 1 x 0.5m at *M. Multicaulis* generating plant height 166.67cm, 341,67cm, and 416,67cm, and at a spacing of 1 x 1m produce 243,33cm, 281,67cm, and 353,33cm. While the species *M. cathyana* had an average growth of 155.00, 273.33, and 306.67 at a spacing of 1 x 0.5 m. 193.33, 196.67 and 400.00 on the spacing of

1 x 1m. These results were significantly differences (P < 0.05) compared with the species *M. Kanva* and *M. Nigra* (Table 1), and comparable to those reported by (Mohamed *et al*., 2013; Sutani *et al*., 1989) that the highest growth mulberry plants are at a distance of 1 x 1 m plants can reach 300 cm. Based on the above results to obtain the highest growth of mulberry plants can use 1 x 0.5 m spacing of the cutting age of 270 days after planting.

Table 1. The average height growth plant several species of mulberry (*Morus spp*) in use spacing of plant, and the cutting age.

Species	Spacing plant	Cutting age (days)		
	(cm)	210	240	270
		..... cm		
M. Kanva	1 x 0,5	290,00 ± 40,93[b]	366,67 ± 86,07[a]	373,33 ± 72,34[a]
	1 x 1	191,67 ± 28,43[b]	231,67 ± 16,07[b]	315,00 ± 65,57[a]
	1 x 1,5	153,33 ± 14,43[b]	155,00 ± 37,75[b]	358,33 ± 30,14[a]
M. nigra	1 x 0,5	353,00 ± 31,22[a]	435,00 ± 31,22[a]	435,33 ± 45,09[a]
	1 x 1	241,33 ± 71,12[a]	266,67 ± 32,53[a]	288,67 ± 27,54[a]
	1 x 1,5	300,00 ± 50,00[a]	311,67 ± 10,41[a]	336,67 ± 23,09[a]
M. multicaulis	1 x 0,5	166,67 ± 43,68[c]	341,67 ± 52,04[b]	416,67 ± 28,87[a]
	1 x 1	281,67 ± 23,63[b]	243,33 ± 80,83[c]	353,33 ± 20,82[a]
	1 x 1,5	273,33 ± 25,17[a]	291,67 ± 28,43[a]	311,67 ± 81,29[a]
M. cathyana	1 x 0,5	155,00 ± 17,32[b]	273,33 ± 77,51[c]	306,67 ± 40,41[a]
	1 x 1	193,33 ± 16,07[c]	196,67 ± 20,21[b]	400,00 ± 50,00[a]
	1 x 1,5	271,67 ± 23,63[a]	288,33 ± 37,53[a]	303,33 ± 15,77[a]

Different superscripts in a column or same row indicate significant differences (P < 0.05).

Dry matter production

The result of the average production in dry matter (DM) mulberry plants are presented in Table 2. Production of DM significant (P < 0.05) against spacing of 1 x 0.5 m, was obtained in the species *M. Kanva* with cutting age of 210 days can be reached 1.96 tons/ha. DM production was also affected by the age of cuts, there is the species *M. Kanva* and *M. Catayana*. Species *M. Kanva* obtain a result of 1.11 tons/ha (210 days), 1.67 tons/ha (240 days) and 2.69 tons/ha (270 days). While *M. catayana* obtain a result of 1.62 tons/ha (210 days), 2,23 tons/ha (240 days) and 3.44 tons/ha (270 days). The data show that DM production more increasing with the longer of cutting age.

Table 2. The evarage dry matter production several species of mulberry (*Morus spp*) in use spacing of plant, and the cutting age.

Species	Spacing plant	Cutting age (days)		
	(cm)	**210**	240	270
		.....ton/ha.....		
M. Kanva	1 x 0,5	1,96 ± 0,26[a]	2,18 ± 0,17[a]	1,75 ± 0,48[a]
	1 x 1	1,86 ± 0,94[b]	3,39 ± 0,08[a]	2,38 ± 1,07[b]
	1 x 1,5	1,11 ± 0,38[c]	1,67 ± 0,34[b]	2,69 ± 0,26[a]
M. nigra	1 x 0,5	1,25 ± 0,94[a]	0,81 ± 0,65[a]	0,99 ± 0,37[a]
	1 x 1	1,22 ± 0,22[a]	1,6 ± 0,41[a]	1,37 ± 0,58[a]
	1 x 1,5	1,14 ± 0,91[a]	1,33 ± 0,94[a]	0,82 ± 0,68[a]
M. multicaulis	1 x 0,5	1,87 ± 1,22[a]	1,26 ± 0,84[a]	0,94 ± 0,64[a]
	1 x 1	1,19 ± 0,78[a]	0,27 ± 0,12[a]	0,38 ± 0,14[a]
	1 x 1,5	0,43 ± 0,21[b]	1,77 ± 0,22[a]	1,60 ± 0,21[a]
M. cathyana	1 x 0,5	1,62 ± 0,35[c]	2,23 ± 0,45[b]	3,44 ± 0,36[a]
	1 x 1	1,45 ± 0,21[a]	1,89 ± 0,23[a]	1,41 ± 0,35[a]
	1 x 1,5	1,38 ± 0,95[a]	2,04 ± 1,09[a]	1,22 ± 0,58[a]

Different superscripts in a column or same row indicate significant differences (P < 0.05).

Production increased at a spacing of 1 x 0.5 m, it is likely caused by the number of plants / ha more than the distance of the plant 1 x 1 m and 1 x 1.5 m. These results differ from the results reported by Eltayb and Warag (2003) showed that the highest production growth and are at a spacing of 1 x 1 m compared with 1 x 0.5 m, 1 x 1.5 m, and 2 x 2 m in some species (*M. alba, M. ma1lotfolia, M. Acidosa,* and *M. mesozygia tiliaefolia*). The same recommendation with a spacing of 1 x 1 m were reported by Sutani et al. (1989). This may occur because of differences in the mulberry species and soil conditions (alluvial soil) used in the study.

The longer age generally will increase production of biomass (Mansyur *et al*., 2005; Elevitch and Francis (2006) and Fuskhah *et al*., 2009). This is related to the use of nutrition obtained in the branch shoots during the growing period and

utilized to the fullest. According Rahman (2002); Winata *et al*. (2012), the longer defoliation allow the plant to increase production as well as the chance a longer time to develop roots as well as the accumulated result of photosynthesis into roots system. Thereby, based on the test results above, to obtain optimum DM production can use a spacing of 1 x 0.5 with cutting age 270 days after planting.

The ratio of leaf / stem

Very important to know that proportion of leaf / stem (Shehu *et al*., 2001), because the forage plants that have much leaves is a good feed quality, then Gustavsson and Martinsson (2004) stated that the parts of the plant are the most palatable and have a higher quality is a fraction of the leaves, affect the amount of consumption and nutrient content. In general, the level of consumption and the amount of nutrients are obtained on the leaves was higher than in the stem (Smart, 1998).

The ratio of leaf / stem mulberry plants in this study (Table 3), shows that the planting distance was not significant (P > 0.05) on the ratio of leaves and stems, but significantly affected by the cutting age. Leaf ratio is highest at the age of 210 days significantly differences (P < 0.05) to the cutting age of 240 days found in the species *M. kanva* with spacing 1x0,5 and 1x1,5. *M. nigra* with spacing 1x0,5, 1x1 and 1x1,5 and *M. Multicaulis* with a spacing of 1x0,5 m. This indicates that the higher age cuts will lower the proportion of leaves obtained.

Table 3. The evarage ratios leaf / stem several species of mulberry (*Morus spp*) in use spacing of plant, and the cutting age

Species	Spacing plant (cm)	Cutting age (days) 210	240	270
M. Kanva	1 x 0,5	0,82 ± 0,28^{a}	0,37 ± 0,11^{b}	0,44 ± 0,26^{ab}
	1 x 1	0,99 ± 0,46^{a}	0,58 ± 0,36^{a}	1,02 ± 0,89^{a}
	1 x 1,5	0,93 ± 0,23^{a}	0,48 ± 0,20^{b}	0,21 ± 0,09^{bc}
M. nigra	1 x 0,5	1,47 ± 0,87^{a}	1,36 ± 1,05^{a}	1,24 ± 1,20^{b}
	1 x 1	1,23 ± 1,03^{a}	1,70 ± 2,12^{a}	0,95 ± 0,04^{b}
	1 x 1,5	1,42 ± 0,82^{a}	1,02 ± 1,01^{b}	0,86 ± 0,63^{ab}
M. multicaulis	1 x 0,5	1,39 ± 0,66^{a}	1,26 ± 0,81^{a}	0,92 ± 0,37^{b}
	1 x 1	1,44 ± 1,47^{a}	1,17 ± 0,89^{a}	0,92 ± 0,43^{a}
	1 x 1,5	1,44 ± 0,87^{a}	0,90 ± 0,74^{a}	0,88 ± 0,68^{a}
M. cathyana	1 x 0,5	0,63 ± 0,24^{a}	0,57 ± 0,17^{a}	0,19 ± 0,08^{a}
	1 x 1	0,83 ± 0,18^{a}	0,58 ± 0,22^{a}	0,19 ± 0,08^{ab}
	1 x 1,5	1,38 ± 0,57^{a}	0,38 ± 0,13^{b}	0,34 ± 0,12^{ab}

Different superscripts in a column or same row indicate significant differences (P < 0.05).

Decrease of ratio leaf in accordance with those reported by (Herdiawan and Suteddi, 2012; Tarin *et al*., 2010; Bonesmo and Belanger, 2002) states that the increase in age of the plant followed by an increase in the proportion of branches as well as the content of the cell walls (fibers) (Djuned *et al.*, 2005). So that when seen from the aspect of its agronomic, the first cut at the age of 210 days is an optimal defoliation management in the utilization of mulberry as forage plants because the leaves possess a fraction higher.

Chemical composition

Table 4. The chemical composition several species of mulberry (*Morus spp*) against the cutting age.

Parameter	Species	Cutting age (days) 210	240	270
		..... %		
BK	*M. Kanva*	31,26 ± 1,35^{b}	31,29 ± 0,99^{bc}	34,54 ± 0,80^{a}
	M. nigra	29,71 ± 0,77^{a}	30,34 ± 0,68^{a}	31,63 ± 1,20^{a}
	M. catayana	26,49 ± 1,23^{b}	29,24 ± 3,04^{a}	31,54 ± 0,43^{ab}
	M. multicaulis	32,67 ± 0,81^{c}	33,08 ± 2,39^{b}	36,69 ± 4,19^{a}
BO	*M. Kanva*	65,77 ± 1,11^{c}	67,83 ± 1,06^{b}	70.13 ± 1.06^{a}
	M. nigra	63,10 ± 3,17^{c}	65,12 ± 3,17^{b}	67,42 ± 3,17^{a}
	M. catayana	67,59 ± 1,08^{b}	69,6 ± 1,07^{b}	71,9 ± 1,07^{a}
	M. multicaulis	67,16 ± 1,37^{b}	69,17 ± 1,38^{b}	71,74 ± 1,38^{a}
PK	*M. Kanva*	20,73 ± 0,53^{a}	20,16 ± 1,92^{a}	21,06 ± 2,06^{a}
	M. nigra	21,2 ± 0,80^{a}	20,63 ± 1,17^{a}	21,73 ± 2,73^{a}
	M. catayana	20,6 ± 0,91^{a}	20,03 ± 1,09^{a}	21,16 ± 2,86^{a}
	M. multicaulis	20,26 ± 1,54^{a}	20,83 ± 2,94^{a}	19,69 ± 1,96^{a}
ADF	*M. Kanva*	36,41 ± 3,83^{a}	36,11 ± 3,19^{a}	36,76 ± 4,62^{a}
	M. nigra	34,6 ± 1,32^{a}	35,4 ± 1,81^{a}	34,3 ± 2,17^{a}
	M. multicaulis	26,09 ± 1,18^{a}	27,19 ± 1,19^{a}	27,99 ± 1,18^{a}

	M. catayana	36,34 ± 3,82[a]	38,18 ± 3,16[a]	38,69 ± 4,46[a]
NDF	*M. Kanva*	35,45 ± 4,46[a]	35,07 ± 2,70[a]	36,76 ± 3,54[a]
	M. nigra	36,38 ± 1,37[a]	37,85 ± 3,16[a]	35,67 ± 3,28[b]
	M. multicaulis	42,55 ± 1,71[a]	42,91 ± 3,85[a]	41,85 ± 0,71[a]
	M. catayana	39,63 ± 4,47[a]	38,94 ± 5,19[a]	40,29 ± 3,72[a]
Lignin	*M. Kanva*	16,06 ± 0,87[a]	16,75 ± 0,79[a]	16,26 ± 1,39[a]
	M. nigra	12,56 ± 1,13[a]	12,28 ± 1,82[a]	12,73 ± 0,53[a]
	M. multicaulis	8,47 ± 1,48[a]	8,6 ± 1,94[a]	8,15 ± 1,32[a]
	M. catayana	9,39 ± 2,43[a]	9,11 ± 1,96[a]	9,48 ± 3,00[a]
Tanin	*M. Kanva*	0,37 ± 0,18[a]	0,37 ± 0,18[a]	0,38 ± 0,16[a]
	M. nigra	0,41 ± 0,25[a]	0,44 ± 0,25[a]	0,39 ± 0,20[a]
	M. multicaulis	0,16 ± 0,07[a]	0,17 ± 0,04[a]	0,17 ± 0,09[a]
	M. catayana	0,19 ± 0,06[a]	0,2 ± 0,08[a]	0,19 ± 0,04[a]

Different superscripts in a column or same row indicate significant differences ($P < 0.05$).

The chemical composition of some species of mulberry plants is shown in Table 4. The average content of dry matter (DM) generated by the treatment of cutting age significantly ($P < 0.05$) found in the species *M. Multicaulis*. linearly acquired content DM rise of 32.67 (210 days), 36.08 (240 days), and 33.69 (270 days). DM levels increase with cutting age treatment. The same thing happened in organic matter content (OM), cutting age significantly affect to increase of OM content, there are in species *M. Kanva* and *M. Nigra*. Cutting age 270 days have the highest yield significantly different with the cutting age of 240 and 210 days after planting. According to Savitri *et al*. (2013), the long age causing the plant to have more opportunities make the process of photosynthesis, enabling the plant increases production of the canopy so that can increase organic matter content in plants.

Cutting age do not affect to increase the content of CP, ADF, NDF, lignin and tannin. The content of CP obtained ranged between 19% -21.73%. This figure is relatively lower than the results Saddul *et al*. (2003), 24.9%. Nguyen and Le (2003) reported the CP content of mulberry plants ranged from 22.2 - 24.3%. Bamicole *et al*. (2005) 23.2%, while Sanchez (2000) reported between 15-28%. In this study the cutting age at the 210 days with an average content of CP (20.69%) has been quite effective cutting as animal feed. The average content of ADF obtained (32.38%), higher than Flemingia (30%) and lower than Acacia (45%) reported by Thanh *et al*. (2004). The average content of NDF obtained (33.99%), higher reported by Jefferson (2005), which contains 30.5% NDF. The average lignin content of each forage mulberry in this study 12.45%, is low compared with reported by Yogesh (2013) amounted to 21.42%. Tannin content obtained by an average of 0.3%, relatively moderate and comparable to the tannin content in some species of mulberry plants (0.13 to 0.36%) were reported Srivastava *et al*. (2006), (16 - 35%) (Chaitali *et al*. 2014). But relatively higher (0.58%) than those reported by Datta (2002).

Conclusion

Concluded that the species *M. Multicaulis* has more advantages than the other three species, the use of a spacing of 1 x 0.5 and cutting age of 270 days after planting showed higher growth of mulberry plants, as well as a lot of advantages to the DM production, the ratio of leaves and stems, and chemical composition especialy to DM and OM content.

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