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Dynamics of Fiber Fraction in Generative Stage of M10-BMR Sorghum Mutant Lines

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Abstract

Sorghum is a potential food crop as forage fodder because of high biomass production, and some lines have high nutritional content and palatabel. The research aimed to investigate the effect of different M10-brown midrib sorghum mutant lines (BMR) and generative phases on dynamics of fiber fraction content of leaves, stems and panicles. The research was conducted at SEAMEO-BIOTROP Bogor, Indonesia, using completely randomized factorial design (3x3) in 3 replicates, followed by Duncan Multiple Range Test (DMRT) if significant effect of the treatment is found. The first factor was BMR sorghum lines (Patir 3.1/non BMR as control, Patir 3.2 and Patir 3.7), and the second factor was the generative phases (flowering, soft dough and hard dough phases).

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The parameters observed were NDF, ADF, lignin, cellulose and hemicellulose content on leaves, stems and panicles. The results showed that NDF and ADF content in the leaves were higher than those in stems and panicles. The lignin content in stems and panicles at soft dough and hard dough phases was lower ($P < 0.01$) than those of the flowering phase. Both sorghum mutant lines and time of harvest did not affect lignin content of leaves ($P > 0.05$). The lignin content of panicles decreased ($P < 0.01$) at soft dough and hard dough phases than those of flowering phase, but sorghum lines did not affect lignin content of panicles ($P < 0.05$). The cellulose content in stems, leaves and panicles at soft dough and hard dough phases were lower than at flowering phase ($P < 0.01$). Hemicellulose content of stems was lower at sorghum lines of P 3.2 and P 3.7 than those of control or P 3.1 ($P < 0.05$) and at soft dough phase, hemicellulose content in stem was lower than of at flowering and hard dough phases.

Keywords: Brown midrib sorghum; mutant line; generative phases; fiber fraction.

1. Introduction

Ruminant animal feed is generally given in the form of forage and concentrates. However, use of concentrate feed impacted on high production cost. To reduce production cost, farmer utilize more forage crop that can meet the needs of nutrition for ruminant mainly protein and energy in the form of a single feed is needed to be developed.

A common single feed source for ruminant livestock is maize (Zea mays L.), that has to be replanted to continue biomass crop production. Another crop plant which potential to be single feed is forage sorghum (Sorghum bicolor), because the nutritional content as good as maize (crude protein content range is 7%-8%) [1, 2, 28]. Forage sorghum produce higher biomass production per year than maize because it can be harvested for 3-4 times in life cycle [3]. However, most of sorghum line has high content of lignin that lead to decrease dry matter digestibility. Plant breeding to reduce lignin content was done by application of nuclear technology through gamma rays irradiation to produce several brown midrib sorghum mutant lines (BMR). The main goal in producing the BMR is to increase the cellulose content and decrease the lignin content. The BMR sorghum has a lower lignin content than those of conventional sorghum lines [4, 5, 6]. Lignin content of non BMR is 2.7-6.4% but BMR 2.8-4.5% [3].

Lignin limit cell wall digestibility (fiber) in ruminant. Lignin content and cell walls of forage are influenced by plant maturity stage, followed by the cell wall thickening, so increased crude fiber content and the lignification process [7]. On forage crops, the presence of lignin, in form of lignohemicellulose and lignocellulosa bonds decrease the forage digestibility in the rumen [8]. Therefore, to support availability of feed, selection and genetic improvement of forage are crucial to be done to find out high biomass production and forage quality by considering the sorghum lines and their harvest times.

Harvest time is an aspect that closely to related to the growth phase of the plant and nutrition in particular fiber content dynamic. Optimum production of BMR can be determined by growth and development of the plant, meanwhile harvest time influences nutrition content and digestibility of the rouhage in ruminant [9]. Based on these idea, the study was designed to recognize the dynamics of fiber fractions in stems, leaves and panicles of several BMR sorghum mutant lines.

2. Materials and Methods

The experiment was conducted in the field with 1500 m^2 at research station of SEAMEO-BIOTROP, Bogor, Indonesia. Sorghum mutan lines consisting of M10-BMR and non BMR are involved. Some fertilizers including manure, urea, TSP, KCl and instrument triple bean balance, measurement instruments, refraktometer, cuttings scissor and caliper were used. Limited amount of pesticide was used to control pest and dieses. Bird attacts was controlled by putting the perforated plastic bag for every panicle.

Factorial completely randomized block design (3 x 3) with three replicates was used as experimental design, and followed by Duncan Multiple Range Test (DMRT) if there was significant effect among treatments. The first factor was sorghum mutant lines consisting of Patir 3.1 (M10-non BMR sorghum mutant line as control line), Patir 3.2 and Patir 3.7 (M10-BMR sorghum mutant lines), were combined with generative stages consisting of flowering stage, soft dough and hard dough stage.

Land preparation was done manually. Before planting 2 ton/ha of manure was administrated to the soil. Fourteen days after land preparation, sorghum mutant lines seed were sown by using sorghum planter at 5 cm depth with 20 x 60 cm planting dimension. Each hole comprised 4-5 seeds of sorghum mutan lines.

The first NPK fertilizer was applied when the plant got 14 days after planting (DAP) with 4:3:2 (g/g/g) equivalent to 270 kg/ha. The some fertilizer was applied again at the age of 50 DAP with 2:4:2 (g/g/g) equivalent to 200 kg/Ha [10] to enhance flowering.

Harvesting was conducted when the plant got early flowering, soft dough and hard dough stage. The flowering stage begun when the pollen color looked yellowish, after the panicle emerged. Soft dough stage was determined by the present of milky liquid by pressing the seeds in between the fingers. Hard dough stages occured when the seeds was getting hard and could not suppresed by fingers [11]. Ten plants were hand harvested at above the first node from the soil surface (approximately 10 cm above ground). Sorghum plants were fragmented into stems, leaves and panicles and weighed.

Stems, leaves and panicles were placed into paper bag individually and dried at 60^0C for about 48 hours to determine the dried weight. Sample were then grainded <1 mm mash for NDF, ADF, lignin, cellulose and hemicellulose contents analysis [16].

3. Results and discussion

3.1. ADF and NDF content of sorghum mutant lines

ADF and NDF represent the fibrous portions of plant material, which influence digestibility and energy available for animals from forage [24]. The ADF and NDF content in the stems, leaves and panicles at flowering, soft dough and hard dough phases are presented in Table 1. There were significant differences (P<0.01) between non BMR and BMR sorghum mutan lines on ADF in stem. The ADF content in M10-BMR sorghum mutant lines (P 3.2 and P 3.7) weresignificantly lower than those of non BMR sorghum mutant line (P 3.1). The P 3.1 had the highest ADF content in stem (45.17%) than P 3.2 (37.32%) and followed by P 3.7 (35.93%) or declined 7.85% and 9.24%. This result is accordingly to [13] that the BMR sorghum had lowest ADF content than non BMR sorghum. The NDF content of the stem was affected by sorghum lines (P <0.05). There were a decreasing trend in NDF stem from non BMR (P 3.1) to M10-BMR sorghum mutan lines (P 3.2 and P 3.7). The stem of M10-non BMR sorghum line (P 3.1) produced the higest NDF content (58.38%), while ADF content in the stem of M10-BMR sorghum mutant lines (P 3.2 and P 3.7) were 53.24% and 51.57% respectively, or reduced by 5.14% and 6.81%.

During generative development, the highest ADF content in stem was found at flowering phase (45.45%) and then slowly decreased at soft dough phase (36.47%) and hard dough phase (36.50%) or decline of 8.98% and 8.95% respectively.

During late generative phases, a dramatic decreased in the ADF content of the panicle was observed. At flowering phase ADF content in the panicle reached up to 48.80% and the ADF content become lower at soft dough and hard dough phases amounting to 25.53% and 19.17%, respectively.

Description: Values followed by a capital letter means high significantly differences (P < 0.01). Values followed by lower case letters means significant differences (P < 0.05). Patir 3.1 = non BMR sorghum mutant line, Patir 3.2 and Patir 3.7 = M10-BMR sorghum mutant lines.

The NDF content in leaves was influenced by sorghum lines (P < 0.05). In non BMR sorghum mutant line (P 3.1) the NDF content in the leaves reached to 67.70% and it was the highest than NDF content in BMR sorghum mutant lines (P 3.2 and P 3.7), those were 64.96% and 66.19% or lower at 2.74% and 1.51%, respectively.

The NDF content in panicles decreased at late generative phases (P<0.01), where at flowering phase NDF content of panicle reached up to 75.36%. At soft dough and hard dough stages, NDF decrease up to 49.27% and 44.31% respectively, or lower by 26.09% and 31.05%. This findings relevan to [15] that NDF content in the panicle decreased during maturation process from early heading to soft dough (6.89% to 34.4%).

Based on the result, the ADF and NDF dynamic in the stems, leaves and panicles are affected by generative phases and sorghum lines. Generative phases could reflect the physiological maturity of plant. The fact, the NDF content in soft dough and hard dough phases comply forage quality standard to be good forage grade (47% - 53%) [27]. The NDF content in stem of M10-BMR sorghum mutant lines (P 3.2 and P 3.7) was better than M10-non BMR sorghum mutant line, the NDF content in stem of P 3.7 and P 3.2 dynamic to 51.57% - 53.24%. In this case, the NDF value of BMR sorghum mutant lines comply to the forage quality standard. The ADF value in stem of P 3.7 and P 3.2 (35. 93 – 37.32%) are comply to the forage quality standard (36% - 40%), according to [27].

Table 1: Mean of ADF and NDF content in stems, leaves and panicles of M10-BMR sorghum mutant lines (%)

Organ Plant	Generative phases	Lines			Mean
		Patir 3.1	Patir 3.2	Patir 3.7	
ADF					
Stems	Flowering	50.81 ± 0.86	45.56 ± 5.27	39.98 ± 2.98	45.45 ± 3.04^{A}
	Soft Dough	41.77 ± 2.09	33.68 ± 1.10	33.96 ± 1.95	36.47 ± 1.71^{B}
	Hard Dough	42.93 ± 3.59	32.72 ± 0.89	33.85 ± 1.65	36.50 ± 2.04^{B}
	Mean	45.17 ± 2.18^{A}	37.32 ± 2.42^{B}	35.93 ± 2.19^{B}	
Leaves	Flowering	50.33 ± 8.34	46.04 ± 7.74	41.98 ± 4.67	46.12 ± 6.92
	Soft Dough	43.49 ± 2.31	40.93 ± 0.43	42.71 ± 0.92	42.38 ± 1.22
	Hard Dough	45.39 ± 1.71	41.77 ± 1.74	43,.16 ± 1.67	43.44 ± 1.22
	Mean	46.40 ± 4.12	42.91 ± 3.30	42.62 ± 2.42	
Panicles	Flowering	45.69 ± 2.86^{B}	48.72 ± 1.14^{AB}	50.80 ± 4.17^{A}	48.40 ± 2.72
	Soft Dough	28.13 ± 1.03^{C}	26.68 ± 1.81^{C}	21.79 ± 1.49^{D}	25.53 ± 1.44
	Hard Dough	19.20 ± 1.,70^{D}	19.45 ± 1.49^{D}	18.88 ± 0.99^{D}	19.17 ± 1.40
	Mean	31.00 ± 1.86	31.62 ± 1.48	30.49 ± 2.22	
NDF					
Stems	Flowering	58.16 ± 9.63	58,36 ± 1.99	56.24 ± 2.89	57.59 ± 4.84
	Soft Dough	56.16 ± 3.48	52.22 ± 10.01	47.98 ± 1.19	52.12 ± 4.89
	Hard Dough	60.81 ± 3.57	49.13 ± 1.64	50.49 ± 3.70	53.48 ± 2.97
	Mean	58.38 ± 5.56^{a}	53.24 ± 4.55^{ab}	51.57 ± 2.59^{b}	
Leaves	Flowering	67.30 ± 2.32	66.93 ± 1.58	67.98 ± 2.11	67.40 ± 2.00
	Soft Dough	68.22 ± 2.98	65.40 ± 1.03	65.31 ± 3.52	66.31 ± 2.51
	Hard Dough	67.59 ± 2.39	62.54 ± 1.04	65.28 ± 2.03	65.14 ± 1.82
	Mean	67.70 ± 2.56^{a}	64.96 ± 1.22^{ab}	66.19 ± 2.55^{ab}	
Panicles	Flowering	75.30 ± 1.85	74.56 ± 5.52	76.21 ± 1.01	75.36 ± 2.79^{A}
	Soft Dough	48.54 ± 7.55	53.05 ± 3.03	46.23 ± 0.45	49.27 ± 3.86^{B}
	Hard Dough	46.39 ± 2.90	46.25 ± 2.46	40.29 ± 6.12	44.31 ± 3.83^{C}
	Mean	56.74 ± 4.10	57.95 ± 3.67	54.24 ± 2.53	

Dynamic of ADF content was consistent with NDF content during generative development of sorghum. There was a decrease trend in ADF and NDF content from flowering phase to soft dough and hard dough phases, it is associated with the need for producing seeds. Soft dough and hard dough phases were the development and seed production phases, consequently there are more nutrients are needed to produce grains [12, 13], while [9, 23] stated that the decline in NDF with increasing maturity stage due to increased of starch proporsion and content. Another factor affectes the decrease of ADF and NDF content were an increase stems sugar levels from the flowering - soft dough - hard dough phases with values 12.01, 13.68 and 14.81 % brix, respectively (unpublished). Sucrose began to accumulate in large amounts in the stem at flowering phase, and the further flowering phase occurs carbohydrates competition between the stem and seeds for growth and development, so that reduced portion of structural carbohydrates [2, 14].

In this study, the average content of NDF flowering phase was 67.40% (leaves), 57.59% (stems) and 75.36% (panicles), while in the soft dough stage NDF content was 66.31% (leaves), 52.12% (stems) and 49.27% (panicles). The datas in this study is slightly different from the results [15] in which the content of NDF in the flowering phase was 66.7% - 67.8% (leaves), 56.3% - 64.2% (stems) and 64.0% - 68.9% (panicles), while the soft dough stage NDF content was 69.3% - 69.6% (leaves), 65.3% - 68.5% (stems) and 34.2% - 38.5% (panicles), this difference due to the differences in the sorghum lines, climatic and field conditions.

3.2. Lignin content of sorghum mutant lines

Lignin is considered an anti-quality component in forages because of its negative impact on the nutritional availability of plant fiber [25]. The lignin content in stems, leaves and panicles of non BMR and BMR sorghum mutan lines in generatives phases are presented in Table 2. In the stems, the non BMR sorghum line (P 3.1) had the higher lignin content at the same generative phase, however the lower lignin content was consistently observed in BMR sorghum mutant lines (P 3.2 and P 3.7). At sorghum non BMR (P 3.1) lignin content stems reaching to 8.95% while the sorghum BMR (P 3.2 and P 3.7) ranges from 5.92% and 5.67%. The mean lignin content of BMR (P 3.2 and P 3.7) decreased significantly ($P<0.01$) by 3.03% and 3.28% respectively, but among the BMR lines (P 3.2 and P 3.7) were not different from each other ($P> 0.05$). There are in agreement with [13] who reported that lignin content of BMR was decreased in comparison with non BMR.

The content of lignin in the stem also influenced by generative phases ($P <0.05$). In the flowering phase, the lignin content in stems reached to 7.90% while the soft dough and hard dough phases around 6.18% and 6.46% respectively or lower at 1.72% and 1.44%, while lignin content in the stems of soft dough and hard dough phase was not significantly different ($P > 0.05$). Our findings are relevance to [13] that harvest at late maturity will lead to produce lower lignin content.

Lignin content in panicles was highly significant affected ($P <0.01$) by generative phases, but the sorghum mutant lines had no effect ($P > 0.05$) to the lignin content in panicles. Lignin content in stems and panicles was influenced by maturity stage. At the older sorghum plants, the lignin content decreases, this is due to the intensive growth of the panicle and the accumulation of starch in grain, as well as the accumulation of sugar in the stem tissue. This phenomena will decrease in the proportion of lignin in plant sorghum [15, 2].

Lignin content in the stem also influenced by BMR lines. In this study lignin content of BMR (P 3.2 and P 3.7) was lower than control (non BMR/P 3.1), this is due to genetic mutations that occur in BMR sorghum causing the reduction lignin content [3, 17, 18, 19]. The decrease of stem lignin on P 3.2 and P 3.7 BMR mutant line of 3.03% and 3.28%, this result is lower than [3] where the lignin content of BMR sorghum decreased to 5-50% in the stem compared to non BMR sorghum.

Table 2: Mean of Lignin content in M10-BMR sorghum mutant lines (%)

Organ Plant	Generative phases	Lines			Mean
		P 3.1	P 3.2	P 3.7	
Stems	Flowering	10.18 ± 0.34	7.70 ± 2.38	5.82 ± 1.75	7.90 ± 1.49[a]
	Soft Dough	8.36 ± 0.18	4.97 ± 0.18	5.21 ± 0.33	6.18 ± 0.23[b]
	Hard Dough	8.32 ± 0.70	5.09 ± 0.19	5.98 ± 0.72	6.46 ± 0.54[b]
	Mean	8.95 ± 0.41[A]	5.92 ± 0.92[B]	5.67 ± 0.93[B]	
Leaves	Flowering	7.65 ± 3.87	4.87 ± 0.18	5.19 ± 1.69	5.90 ± 1.92
	Soft Dough	7.12 ± 0.24	5.29 ± 0.37	6.10 ± 0.49	6.17 ± 0.37
	Hard Dough	8.14 ± 0.40	6.51 ± 0.33	6.65 ± 0.25	7.10 ± 0.32
	Mean	7.64 ± 1.51	5.55 ± 0.29	5.98 ± 0.81	
Panicles	Flowering	9.61 ± 1.57	9.26 ± 1.07	9.38 ± 0.55	9.42 ± 1.06[A]
	Soft Dough	8.61 ± 0.53	6.45 ± 1.65	5.84 ± 1.38	6.96 ± 1.19[B]
	Hard Dough	6.55 ± 2.02	6.55 ± 0.61	6.93 ± 1.22	6.68 ± 1.28[B]
	Mean	8.25 ± 1.37	7.42 ± 1.11	7.38 ± 1.05	

Description : Values followed by a capital letter means high significantly differences ($P < 0.01$). Values followed by lower case letters means significantly differences ($P < 0.05$). Patir 3.1 = non BMR sorghum mutant line, Patir 3.2 and Patir 3.7 = M10-BMR sorghum mutant lines.

3.3. Cellulose and Hemicellulose content of sorghum mutant lines

Cellulose is the single most abundant component in cell walls and composed exclusively of linear glucose chains, and hemicellulose is polysaccharides extracted with alkali from delignified cell walls [26]. Cellulose and hemicellulose content of non BMR and BMR sorghum mutant lines presented in Table 3. Cellulose content in the stem of non BMR sorghum mutant line (P 3.1) produced the highest cellulose content (35.39%) while the BMR mutant lines (P 3.2 and P 3.7) produced lower cellulose content (30.43% and 29.43%) or decreased 4.96% and 5.96% respectively. Cellulose content decreased with advanced generative phases (soft dough and hard dough phases). At flowering phase, cellulose content was 36.43%, mostly higher than soft dough and hard dough phases (29.8% and 29.02%), respectively.

The cellulose content in the leaves was not affected by sorghum lines ($P > 0.05$) but more influenced by generative phases ($P < 0.01$). The highest cellulose content was produced in the harvesting flowering phase (35.32%) and then decreased at the soft dough stage (31.98%) and the hard dough stage (30.55%), cellulose content in the soft dough and hard dough phases was not significantly different ($P > 0.05$). Cellulose content in panicles was affected by the interaction between lines and generative phases, the highest cellulose content was found on BMR lines (P 3.7 and P 3.2) and the flowering phase (39.62% and 38.38%) while the lowest cellulose content of panicle harvested at hard dough phase.

Table 3: Mean content of cellulose and hemicellulose in M10-BMR sorghum mutant lines (%)

Organ Plant	Generative phases	Lines			Mean
		P 3.1	P 3.2	P 3.7	
Cellulose					
Stems	Flowering	39.16 ± 1.43	36.82 ± 3.12	33.31 ± 1.32	36.43 ± 1.96^{A}
	Soft Dough	33.05 ± 2.04	28,21 ± 1.16	28.13 ± 1.99	29.80 ± 1.73^{B}
	Hard Dough	33.95 ± 3.02	26.25 ± 0.95	26.85 ± 1.84	29.02 ± 1.94^{B}
	Mean	35.39 ± 2.16^{A}	30.43 ± 1.74^{B}	29.43 ± 1.72^{B}	
Leaves	Flowering	37.32 ± 5.10	35.55 ± 3.58	33.10 ± 3.01	35.32 ± 3.90^{A}
	Soft Dough	31.87 ± 2.56	31.39 ± 0.41	32.68 ± 0.66	31.98 ± 1.21^{B}
	Hard Dough	31.28 ± 1.95	30.00 ± 1.32	30.38 ± 1.80	30.55 ± 1.69^{B}
	Mean	33.49 ± 3.21	32.31 ± 1.77	32.05 ± 1.82	
Panicles	Flowering	35.19 ± 1,97^{B}	38.38 ± 0.94^{A}	39.62 ± 3.22^{A}	37.73 ± 2.04
	Soft Dough	18.58 ± 0,63^{C}	18.76 ± 0.49^{C}	16.32 ± 1.80^{C}	17.89 ± 0.97
	Hard Dough	11.91 ± 1,60^{D}	9.80 ± 0.95^{D}	10.45 ± 0.38^{D}	10.72 ± 0.98
	Mean	21.89 ± 1.40	22.32 ± 0.79	22.13 ± 1.80	
Hemicellulose					
Stems	Flowering	23.80 ± 3.33	23,04 ± 2,25	22,94 ± 1,60	23,26 ± 2,39^{A}
	Soft Dough	23.10 ± 1.78	17,93 ± 1,81	19,85 ± 2,43	20,29 ± 2,01^{B}
	Hard Dough	26.86 ± 0.57	22,88 ± 1,13	23,64 ± 2,73	24,46 ± 1,48^{A}
	Mean	24.59 ± 1.89^{a}	21,28 ± 1,73^{b}	22,14 ± 2,25^{b}	
Leaves	Flowering	31,96 ± 2.29	31.39 ± 2.33	32.10 ± 2.74	31.82 ± 2.46^{b}
	Soft Dough	33,51 ± 0.62	34.02 ± 0.77	32.63 ± 2.89	33.39 ± 1.42^{b}
	Hard Dough	36,31 ± 2.15	32.55 ± 1.77	34.90 ± 0.26	34.59 ± 1.40^{a}
	Mean	33,92 ± 1.69	32.65 ± 1.63	33.21 ± 1.96	
Panicles	Flowering	40.10 ± 3.62	36.17 ± 5.78	36.59 ± 3.06	37.62 ± 4.15^{A}
	Soft Dough	29.96 ± 7.13	34.29 ± 3.33	29.91 ± 2.20	31.38 ± 4.22^{B}
	Hard Dough	34.48 ± 2.40	36.45 ± 2.98	29.84 ± 5.96	33.59 ± 3.78^{B}
	Mean	34.85 ± 4.39	35.64 ± 4.03	32.11 ± 3.74	

Description: values followed by a capital letter means high significantly differences ($P < 0.01$). values followed by lower case letters means significantly differences ($P < 0.05$). Patir 3.1 = non BMR sorghum mutant line, Patir 3.2 and Patir 3.7 = M10-BMR sorghum mutant lines.

Hemicellulose content of the stem was affected by sorghum lines ($P < 0.05$). Non BMR line (P 3.1) produced highest hemicellulose content (24.59%) and higher than BMR lines (P 3.7 and P 3.2) with 22.14% and 21.28%. Hemicellulose content between BMR lines did not significantly difference ($P > 0.05$). Hemicellulose content of stem was also influenced by generative phases (P <0.01), hemicellulose content of the stem at flowering phase did not significantly difference (P> 0.05) with the hard dough phase but significant (P <0.01) in the soft dough phase. Hemicellulose content of the leaves was not affected by sorghum lines (P > 0.05) but more influenced by generative phases (P <0.05). The hard dough phase produced the highest hemicellulose content (34.59%) compared to the soft dough and flowering phases (33.39% and 31.82%). Hemicellulose content of the panicle was not affected by sorghum lines (P > 0.05) but it was more influenced by generative phases (P < 0.01), the flowering phase produced the highest hemiselulose content (37.62%), while hemicellulose content at soft dough and hard dough phases was 31.38% and 33.59% respectively. Hemicellulose content of panicle at soft dough and hard dough phase was not significantly difference (P> 0.05).

The results showed that harvesting at late generative phase will decrease the cellulose content, according to the statement [20, 21] that the cellulose content decreased with the increase of plants maturity. Another factor that led to a decrease in cellulose and hemicellulose content due to the increase in sugar content in sorghum stalks. [20] found that a decrease in hemicellulose, cellulose and lignin in sorghum with the increase on maturity due to the increase of non-structural carbohydrates content (sugar content). The average stem cellulose and hemicellulose content in this study was 29.80% and 20.29% (soft dough phase), almost the same as the results [22] in which the content of cellulose and hemicellulose in the stem of wray sorghum at soft dough phase was 25% and 23%. It is expected that the M10-BMR sorghum mutant lines has better digestibility for ruminant in further study.

4. Conclusion

M10-BMR sorghum mutan lines had lower ADF, NDF, lignin, cellulose and hemicellulose content than non BMR sorghum mutant lines. Dynamics of the ADF, NDF, lignin, cellulose content in the stem and panicle at generative stage tend to decline from flowering stage to soft dough and hard dough stage. Meanwhile hemicellulose tended to increase in leaves during generative development stage.

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