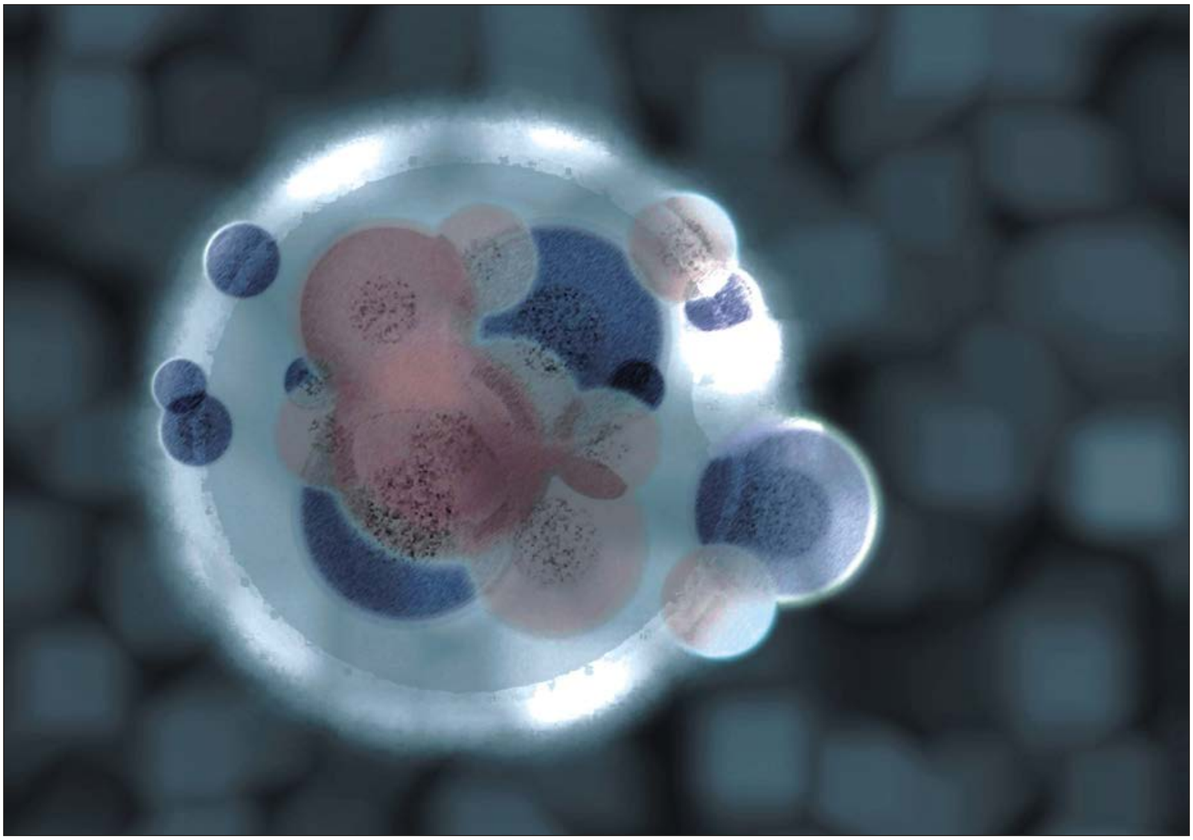

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Chemical Composition of Ryegrass (*Lolium multiflorum*) at Different Stages of Growth and Ryegrass Silages with Additives

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Abstract: The study was conducted to determine the effect of additives on the chemical composition of ryegrass (*L. multiflorum*) cut at five different stages of growth. They were harvested fortnightly as from September to November 2003.The grass samples were ensiled and then analysed for the proximate composition, *in vitro* digestibility nutrient and mineral elements. The young and immature plants were highly digestible but as maturity increased, yield also increased, but quality decreased. The digestibility decreased as lignification of the plant material increased with plant maturity.

Key words: Composition, ryegrass, plant maturity

INTRODUCTION

With increasing demand for meat, milk and other animal protein sources, there is need to increase productivity of each hectare of grazing land without degrading the natural resources of the country. This can be achieved by increasing production of cultivated forages. High quantity and quality of milk and meat production requires a high level of nutrients and good forage which should always be available for the grazing animals. Botswana's production of silage, hay and fodder is still on a small scale and mainly done by commercial and institutional farms[1]. The chemical composition of grass is greatly influenced by the stage of growth of the plants, the botanical composition of the sward, the nutrient status of the soil and the climate and the management of the sward. The digestibility of a grass is the percentage of the dry matter that the animal can digest and utilize. It is expressed as dry matter, organic matter, or total digestible nutrient (TDN), is the most commonly used measure of value. Its common use is related to the relative ease with which it can be applied as well as to its reproductivity[2].

Ryegrass is one of the most widely grown cool season grasses in the world. They have numerous desirable agronomic qualities. They establish rapidly, have a long growing season, are high yielding under favourable environments when supplied with adequate nutrients, posses high nutrient contents and can be grazed and used for hay or silage. They are indigenous to Europe, Asia and North Africa, but are grown worldwide. The ryegrasses are considered to be high quality forages and their high digestibility makes them suitable for all types of ruminants[3]. The study on ryegrass grown in Notwane farm (BCA) was conducted to determine the stage of growth at which it is more nutritious and to determine its suitability for silage production with different levels of additives at each stage.

MATERIALS AND METHODS

Sampling of annual ryegrass (*Lolium multiflorum*) at five stages of growth were done. The grass sample was hand clipped at grazing height which was 2 cm above the ground using a secueter from Notwane farm (BCA), the sample were then collected in white sampling bags. The fresh samples in 12 bags were cut 2 cm length pieces and some were put in paper bags, then weighed in duplicates immediately after cutting and then were oven dried at 60°C for 72 h. The samples were put in different plastic bags, the first bag was a control, the second sample was added $CaCO_3$ at 0.25% the amount of ryegrass, the third was ryegrass mixed with 10% sorghum, the forth was ryegrass mixed with 5% molasses, the fifth was ryegrass mixed with 1% urea and 5% molasses, the last was a mixture of ryegrass with all the above additives and this sample was mixed with 10% water. This was done in preparation of silage making.

Then all the samples were shaken vigorously to make a good mixture. These were then pressed to remove air pockets in the sample; to make the mixture airtight. Then the bags were sealed and tied with a polythene string and the six sealed samples were then put in one plastic bag, which was sealed. The bags were placed in a save place for 21 days for silage to be ready. After 21 days each sample was opened and put in paper bags. These were then placed in an oven at 60°C for 72 h. Then the oven-

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dried samples were weighed to determine dry matter. The samples were milled through a 2 mm screen using a laboratory hammer mill. The ground samples were labeled and stored in plastic bottles. Proximate analysis of the samples (ash, crude protein and fiber) was done in duplicates using procedures of AOAC[4]. Minerals were determined using the flame photometer and atomic spectrometer, thus potassium and sodium were determined by flame photometer, calcium, copper, magnesium, iron, zinc and manganese were determined by atomic spectrometer[4]. The dry matter true digestibility was determined by the *in vitro* digestibility method. The constituent of acid detergent fibre and neutral detergent fibre were determined by methods of Goering and Van Soest[2]. The data was subjected to analysis of variance, using general linear model procedure (Pro GLM) of SAS[5] statistical package (Statistical Analitical Inc. Cary, North Carolina, USA). Mean values were compared with Duncan's New Multiple Range Test.

RESULTS AND DISCUSSION

Tables 1 to 10 indicates the crude protein, *in vitro* dry matter digestibility, acid detergent fibre, acid detergent lignin, neutral detergent fibre, organic matter, ash and also the major and minor minerals determined at different stages of growth of *L. multiflorum* grass and silages ensiled with different additives.

The ADF and NDF values obtained in this study for fresh ryegrass (Table 1) are similar to the findings of Johnson[6] but the crude protein contents were lower than those reported for ryegrass in Canada[6]. Table 2 shows the mineral contents of ryegrass at different stages of growth. All the major and minor minerals fluctuated with plant maturity. Table 3 and 4 indicate the nutritive and mineral composition of ensiled *L. multiflorum* at different stages of growth. It showed that ADF, NDF and ADL increased with maturity while IVTD and CP decreased with plant age post germination. The individual macro and minor minerals fluctuated with maturity.

Different materials or products have been added to forage prior to ensiling over the years. The reason for these additives is to produce an ensiled feedstuff with a greater nutritive value and greater acceptance by the animal. Additives can be classified as fermentation inhibitors and fermentation stimulants. Nutrients sources such as ground sorghum grain, molasses, urea, $CaCO_3$ were used in this study as additives. Molasses improved the fermentation of the ensiled ryegrass while urea increased the protein content of the ryegrass silage. These are shown in the nutritive values of the silages shown in Table 5 to 10. Production of silages will enhance feed availability for grazing ruminants in Botswana whose production currently is constrained by inadequate feed availability.

Table 5 and 6 indicate the nutritive and mineral composition of *L. multiflorum* with ground sorghum additive ensiled at different stages of rye grass growth. There was a decrease in IVTD and CP with maturity. The NDF, ADF and ADL increased while the minerals fluctuated with maturity.

Table 1: Nutritive composition of *L. multiflorum* grass harvested at different stages of growth

	Period				
Parameters	First cut	Second cut	Third cut	Fourth cut	Fifth cut
Days pg	60	74	88	102	116
IVTD (%)	78.00±2.24	72.00±2.97	68.00±3.51	59.00±2.86	55.00±1.81
NDF (%)	52.00±0.59	52.00±1.26	55.50±1.10	58.50±1.28	60.00±0.71
ADF (%)	32.00±1.09	32.50±1.29	34.00±1.43	35.50±0.81	37.00±1.23
ADL (%)	02.50±0.75	04.00±1.11	04.50±1.004	07.50±1.08	08.50±1.05
CP (%)	14.13±0.46	12.94±0.23	11.25±0.51	10.38±0.16	08.24±0.17
ASH (%)	08.00±0.72	08.25±2.13	08.75±1.02	09.75±0.88	10.75±0.91

±SE, Days pg = Days post germination

Table 2: Mineral composition of *L. multiflorum* grass harvested at different stages of growth

	Period				
Parameters	First cut	Second cut	Third cut	Fourth cut	Fifth cut
Days pg	60	74	88	102	116
Ca (%)	00.37±0.08	00.53±0.10	00.40±0.04	00.36±0.01	00.36±0.06
P (%)	00.40±0.08	00.53±0.02	00.41±0.02	00.26±0.01	00.34±0.01
K (%)	00.14±0.02	00.18±0.02	00.21±0.01	00.18±0.01	00.21±0.01
Na (%)	00.18±0.04	00.16±0.03	00.15±0.01	00.05±0.01	00.10±0.10
Mg (%)	00.18±0.02	00.37±0.04	00.20±0.01	00.17±0.008	00.20±0.02
Zn (ppm)	37.60±0.16	198.30±1.33	41.70±0.11	36.30±0.21	36.60±0.07
Fe (ppm)	272.60±2.03	240.30±0.12	221.00±1.70	350.20±0.56	249.40±1.13
Cu (ppm)	05.10±0.04	05.80±0.03	02.80±0.06	02.00±0.02	06.40±0.04
Mn (ppm)	43.40±0.19	50.60±0.32	51.60±0.33	47.80±0.12	53.80±0.23

±SE, Days pg = Days post germination

Table 3: Nutritive composition of ensiled *L. multiflorum* harvested at different stages of growth

	Periods				
Parameters	First cut	Second cut	Third cut	Fourth cut	Fifth cut
Days pg	60	74	88	102	116
IVTD (%)	74.00±2.97	66.00±2.91	64.00±3.51	62.00±2.86	60.00±1.81
NDF (%)	51.00±1.26	51.50±1.23	54.00±1.10	58.00±1.28	59.50±0.71
ADF (%)	30.00±1.29	31.50±1.27	33.50±1.43	36.00±0.86	37.50±1.23
ADL (%)	04.50±1.11	04.80±1.16	06.00±1.004	07.50±1.08	08.00±1.05
CP (%)	13.95±0.23	12.85±0.24	11.69±0.51	10.34±0.16	08.60±0.13
ASH (%)	08.25±2.13	08.50±2.11	08.80±1.02	09.50±0.88	10.00±0.91

±SE, Days pg = Days post germination

Table 4: Mineral composition of silaged *L. multiflorum* harvested at different stages of growth

	Periods				
Parameters	First cut	Second cut	Third cut	Fourth cut	Fifth cut
Days pg	60	74	88	102	116
Ca (%)	00.59±0.10	00.57±0.17	00.52±0.04	00.47±0.01	00.51±0.06
P (%)	00.56±0.02	00.57±0.08	00.59±0.02	00.44±0.01	00.46±0.07
K (%)	00.14±0.02	00.16±0.01	00.20±0.08	00.18±0.01	00.25±0.04
Na (%)	00.01±0.03	00.02±0.03	00.01±0.01	00.01±0.09	00.01±0.10
Mg (%)	00.29±0.04	00.29±0.01	00.28±0.01	00.17±0.008	00.23±0.02
Zn (ppm)	66.80±1.33	56.80±1.34	40.10±0.17	43.00±0.29	38.90±0.07
Fe (ppm)	343.00±0.17	333.00±0.11	347.00±1.70	286.30±0.56	284.50±1.13
Cu (ppm)	07.10±0.03	06.90±0.02	06.50±0.06	06.40±0.02	06.60±0.04
Mn (ppm)	51.80±0.38	53.80±0.32	59.50±0.33	67.50±0.12	62.00±0.23

±SE, Days pg = Days post germination

Table 5: Nutritive composition of ensiled *L. multiflorum* with ground sorghum as additive

	Periods				
Parameters	First cut	Second cut	Third cut	Fourth cut	Fifth cut
Days pg	60	74	88	102	116
IVTD (%)	74.00±2.24	69.00±2.97	65.00±3.51	52.00±2.86	61.00±1.81
NDF (%)	50.00±0.59	51.00±1.26	52.00±1.10	59.00±1.28	59.00±0.71
ADF (%)	30.50±1.09	31.00±1.27	33.00±1.43	35.00±0.816	36.00±1.23
ADL (%)	02.50±0.75	04.00±1.16	05.50±1.04	07.00±1.08	08.00±1.05
CP (%)	14.83±0.47	14.70±0.34	10.79±0.52	09.53±0.13	08.94±0.17
ASH (%)	09.25±0.72	10.00±2.13	11.00±1.02	12.25±0.88	13.50±0.91

±SE, Days pg = Days post germination

Table 6: Mineral composition of ensiled *L. multiflorum* with ground sorghum as additive

	Periods				
Parameters	First cut	Second cut	Third cut	Fourth cut	Fifth cut
Days pg	60	74	88	102	116
Ca (%)	00.37±0.07	00.33±0.10	00.37±0.04	00.45±0.01	00.31±0.06
P (%)	00.51±0.08	00.51±0.02	00.48±0.05	00.42±0.01	00.30±0.07
K (%)	00.14±0.01	00.15±0.02	00.21±0.01	00.19±0.01	00.17±0.04
Na (%)	00.11±0.06	00.12±0.03	00.09±0.01	00.05±0.01	00.08±0.10
Mg (%)	00.20±0.01	00.18±0.04	00.24±0.08	00.23±0.01	00.20±0.02
Zn (ppm)	42.30±0.16	38.30±1.33	38.00±0.10	35.70±0.29	36.80±0.07
Fe (ppm)	228.20±2.36	237.40±0.17	235.70±1.75	342.70±0.56	209.60±1.13
Cu (ppm)	06.40±0.04	05.90±0.03	03.90±0.06	03.80±0.02	04.00±0.04
Mn (ppm)	38.40±0.17	51.20±0.32	53.00±0.33	62.30±0.12	58.40±0.29

±SE, Days pg = Days post germination

Table 1 showed that IVTD and CP decreased with increased maturity at different stages of growth from first cut to the fifth cut, while NDF, ADF and ADL increased with maturity. Gargano *et al.*[7] stated that crude protein content in grasses can have significant effect on digestibility. When it exceeds 7%, digestibility does not appear to be affected but if it falls below 7%, microbial activity in the rumen is depressed by lack of nitrogen and it results in incomplete utilization of structural carbohydrates in ingested grass and a slow rate of passage of the digesta[7].The cell wall contents increased with plant maturity and the cell wall fraction is less digestible because of lignification. This resulted in rapid decline in digestibility of the stem fraction compared to the leaf fraction with advancing maturity. There was no significant increase or decrease in total mineral content with maturity. Individual major and minor minerals fluctuated with plant maturity.

Table 7: Nutrient composition of ensiled *L. multiflorum* with $CaCO_3$ as additive

	Periods				
Parameters	First cut	Second cut	Third cut	Fourth cut	Fifth cut
Days pg	60	74	88	102	116
IVTD (%)	76.00±2.27	67.00±2.97	63.00±3.50	58.00±2.86	54.00±1.81
NDF (%)	50.00±0.59	53.00±1.26	54.00±1.19	60.00±1.28	60.00±0.71
ADF (%)	31.00±1.01	31.50±1.29	33.50±1.43	36.00±0.81	37.00±1.23
ADL (%)	03.00±0.75	04.00±1.11	06.50±1.04	07.00±1.08	07.50±1.05
CP (%)	14.07±0.46	12.84±0.23	11.06±0.51	09.92±0.16	09.12±0.13
ASH (%)	08.00±0.72	08.25±2.13	08.50±1.08	09.25±0.88	10.00±0.91
Ca (%)	00.91±0.08	01.23±0.17	00.84±0.04	01.04±0.01	00.98±0.05
P (%)	00.58±0.04	00.61±0.02	00.41±0.05	00.32±0.08	00.43±0.01
K (%)	00.17±0.02	00.16±0.02	00.24±0.01	00.20±0.01	00.22±0.01
Na (%)	00.06±0.04	00.04±0.03	00.04±0.01	00.05±0.09	00.04±0.11
Mg (%)	00.18±0.01	00.27±0.04	00.22±0.08	00.23±0.08	00.23±0.03
Zn (ppm)	39.20±0.16	36.30±1.34	36.20±0.17	37.40±0.29	33.70±0.07
Fe (ppm)	229.40±2.03	243.60±0.11	265.00±1.70	277.10±0.56	264.60±1.13
Cu (ppm)	07.20±0.04	07.30±0.03b	06.10±0.01	06.20±0.02	05.20±0.04
Mn (ppm)	53.30±0.18	57.90±0.32	50.90±0.33	54.70±0.12	52.70±0.23

Days pg = Days post germination

Table 8: Nutrient composition of ensiled rye grass with molasses as additive

	Periods				
Parameters	First cut	Second cut	Third cut	Fourth cut	Fifth cut
Days pg	60	74	88	102	116
IVTD (%)	79.00±2.24	76.00±2.91	72.00±3.51	69.00±2.86	61.00±1.81
NDF (%)	51.50±0.59	53.00±1.26	53.00±1.10	59.00±1.28	59.00±0.71
ADF (%)	31.50±1.09	32.00±1.29	34.50±1.43	35.50±0.81	37.00±1.24
ADL (%)	02.50±0.75	04.00±1.11	06.50±1.00	06.50±1.08	08.00±1.04
CP (%)	14.68±0.46	13.07±0.23	11.48±0.51	10.43±0.16	09.03±0.13
ASH (%)	08.00±0.76	08.75±2.13	09.00±1.028	10.00±0.88	11.00±0.91
Ca (%)	01.72±0.08	01.41±0.17	01.12±0.04	00.83±0.01	00.95±0.05
P (%)	00.65±0.08	00.44±0.02	00.39±0.02	00.33±0.08	00.43±0.01
K (%)	00.17±0.02	00.20±0.02	00.25±0.01	00.22±0.01	00.24±0.01
Na (%)	00.02±0.04	00.02±0.03	00.01±0.01	00.01±0.09	00.01±0.10
Mg (%)	00.39±0.01	00.40±0.04	00.24±0.01	00.26±0.08	00.32±0.02
Zn (ppm)	44.80±0.16	34.30±1.33	38.10±0.17	42.10±0.29	38.00±0.07
Fe (ppm)	274.80±2.06	278.50±0.17	287.60±1.70	299.30±0.56	286.10±1.13
Cu (ppm)	06.30±0.04	06.20±0.03	06.00±0.06	05.10±0.02	05.50±0.04
Mn (ppm)	37.20±0.18	28.60±0.32	23.30±0.33	28.20±0.12	25.90±0.23

±SE, Days pg = Days post germination

Table 9: Mineral and nutritive composition of ensiled *L. multiflorum* with Urea and molasses harvested at different stages of growth

	Periods				
Parameters	First cut	Second cut	Third cut	Fourth cut	Fifth cut
Days pg	60	74	88	102	116
IVTD (%)	80.00±2.24	75.00±2.07	73.00±3.51	65.00±2.68	63.00±1.81
NDF (%)	50.00±0.59	52.00±1.26	53.00±1.19[a]	57.50±1.28	60.00±0.78
ADF (%)	32.50±1.09	32.00±1.29	34.50±1.43	36.00±0.81	37.00±1.23
ADL (%)	03.00±0.75	04.00±1.11	06.50±1.04	08.00±1.08	08.50±1.05
CP (%)	15.88±0.46	14.88±0.23	14.48±0.51	12.39±0.16	11.84±0.17
ASH (%)	08.00±0.72	09.00±2.13	09.50±1.02	10.00±0.88	10.50±0.91
Ca (%)	01.92±0.087	02.02±0.17	01.23±0.04	00.85±0.07	01.07±0.05
P (%)	00.57±0.04	00.62±0.08	00.39±0.02	00.32±0.08	00.36±0.01
K (%)	00.19±0.02	00.22±0.02	00.24±0.01	00.19±0.01	00.25±0.04
Na (%)	00.03±0.06	00.02±0.03	00.03±0.01	00.01±0.09	00.01±0.10
Mg (%)	00.43±0.01	00.52±0.04	00.34±0.01	00.25±0.08	00.31±0.02
Zn (ppm)	33.90±0.16	39.40±1.33	40.80±0.17	38.80±0.29	38.40±0.07
Fe (ppm)	266.80±2.06	242.10±0.11	248.50±1.70	251.30±0.56	257.40±1.13
Cu (ppm)	07.20±0.04	07.10±0.03	06.50±0.01	06.00±0.02	05.80±0.04
Mn (ppm)	36.50±0.18	43.80±0.32	42.80±0.33	45.80±0.12	45.20±0.23

±SE, Days pg = Days post germination

Table 3 to 10 showed that IVTD and CP of the silaged, both treated with additives and the plain one decreased with advanced stages of growth from the first harvest to the fifth harvest. The digestibility seemed to be best when silages were treated with molasses, urea and molasses and the one treated with all additives. Molasses acted as a fermentation stimulant by encouraging the development of lactic acid bacteria. Table 7 to 10 indicated

Table 10: Mineral and nutritive composition of ensiled *L. multiflorum* with all additives harvested at different stages of growth

Parameters	Periods				
Periods	First cut	Second cut	Third cut	Fourth cut	Fifth cut
Days pg	60	74	88	102	116
IVTD (%)	80.00±2.27	78.00±2.91	75.00±3.50	66.00±2.86	65.00±1.81
NDF (%)	50.00±0.59	53.00±1.26	55.00±1.19	58.00±1.28	60.00±0.71
ADF (%)	31.00±1.09	33.00±1.29	34.50±1.43	36.50±0.81	37.50±1.23
ADL (%)	02.50±0.75	04.00±1.11	06.50±1.04	07.00±1.08	08.00±1.05
CP (%)	16.17±0.46	15.86±0.34	13.99±0.51	13.81±0.16	13.06±0.17
ASH (%)	18.25±0.72	22.25±2.13	05.25±1.02	04.50±0.88	04.50±0.91
Ca (%)	01.78±0.07	02.05±0.10	01.26±0.04	01.34±0.01	01.10±0.05
P (%)	00.61±0.08	00.51±0.02	00.40±0.05	00.33±0.01	00.34±0.07
K (%)	00.15±0.02	00.24±0.02	00.23±0.01	00.20±0.01	00.23±0.01
Na (%)	00.18±0.04	00.10±0.03	00.12±0.01	00.09±0.09	00.11±0.10
Mg (%)	00.40±0.01	00.50±0.01	00.31±0.01	00.29±0.08	00.31±0.02
Zn (ppm)	36.30±0.16	03.58±1.34	37.10±0.10	41.00±0.20	37.60±0.07
Fe (ppm)	254.00±2.03	242.80±0.17	242.10±1.70	257.70±0.56	228.10±1.13
Cu (ppm)	06.60±0.04	06.10±0.02	06.50±0.01	06.20±0.02	05.09±0.04
Mn (ppm)	47.90±0.18	39.80±0.38	37.10±0.33	35.80±0.12	35.90±0.23

±SE, Days pg = Days post germination

nutritive and mineral composition of *L. multiflorum* ensiled with $CaCO_3$, *L. multiflorum* with molasses, *L. multiflorum* with urea and molasses and *L. multiflorum* with all additives, respectively at different stages of growth.

The study shows that ensiling ryegrass with additives improved the nutrient composition of the silages especially when the additives included a source of sugar like molasses and the digestibility improved compared to silages without molasses additive. Silage maintains feed in a succulent form which enhances digestibility of the feed and improves nutrient availability to the animals. Therefore, production of ryegrass pasture in the cool season in Botswana and ensiling it for the dry season feeding will improve animal productivity since the ensiled feedstuff retains a lot of nutrients. The nutritive quality of ryegrass decreased with plant maturity while the biomass production increased. Therefore, it is important to balance biomass quantity with feed quality when utilizing ryegrass as forage. As a result, it is ideal to harvest ryegrass at about 90 days (3 months) post germination to optimize forage quantity and quality since plant lignification increased with plant maturity and digestibility decreased.

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