Research Article

Evaluation of Sunflower-Maize Silage for Yield and Quality Traits

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Abstract | Silage is the term used for forage with a high moisture content preserved by fermentation. The main objectives of making silage are to preserve forage for use in those seasons when fresh forage is not available, to preserve forage when there is a surplus of it during the growing season, and to preserve forage that cannot be grazed. The experiment was carried out at research area, Department of Agronomy, College of Agriculture, University of Sargodha to evaluate the combined effect of sunflower and maize crop for the quality production of silage for enhancing the growth and production in the animals. Six maize hybrids were used along with the sunflower, tree were twelve treatments, each maize with sunflower as intercrop and only maize hybrids as solo crop. Outcome of research revealed that both of sunflower heads and maize plants have better combination for the silage production and the quality parameters like pH, moisture content, protein content, fat content and ash contents. The moisture contents of both the samples and combined silage had not much difference among them, but the protein content, fat content and the pH of the combined silage had remarkable difference among them. The Syngenta-8711 + sunflower and Monsanto-6142 + sunflower varieties were best and had maximum mean values for most of quality parameters, (Fat contents: 14.99%, moisture contents: 38.66%, protein contents: 17.41% and pH: 4.10). These varieties can be grown as intercrop with sunflower to get higher yield and quality of silage.

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Introduction

Livestock sector of Pakistan has an important role in Pakistans agriculture system as a major portion of land area used in Pakistan is under fodder and forage cultivation. In agriculture, livestock as a subsector contributes a major part to value addition in agriculture. Currently, it contributes 60.6% to overall agriculture and 11.7% to GDP during 2019-20. Gross value addition increased with 2.5% during last year (Pakistan Economic Survey, 2019-20). There is continuous growth in population, urbanization is increasing, per capita income is increasing and apart from all this, there are increasing opportunities for

the export of livestock products like milk, meat and other products that are directly made from milk and meat (Khan *et al*., 2021). To meet up the growing demands of the continuously growing population and to take advantage of the vast exporting opportunity, it is important to improve the production from the livestock sector. Livestock production cannot be enhanced without providing quality feed to the livestock heads. In tropical areas, fodder shortage, low yield and fodder scarcity periods significantly reduce livestock productivity (Sarwar *et al*., 2002; Ali *et al*., 2021). Fodder preservation is best way to overcome the scarcity period (Mehmood *et al*., 2020). Different ways have been used to preserve the surplus fodder. Fodder in the form of hay or silage are preserved for growth and milk production of animals throughout the year (Hall and Mertens, 2012). In developing countries, due to lack of drying facility, hay making is highly dependent on weather. Silage could be used at any time, particularly during drought periods (Wilkinson *et al*., 2018).

Feeding is the most imperative factor in successful nutrition of the livestock animals. If good quality feeding is provided to the animals in proper quantities, only then can they be expected to perform at their potential (Young, 2013). If the animals are fed more than their required quantity, then it will be a waste of resources and may lead to health problems in the farm animal (Van-Soest, 1994). Feeding animals optimally requires practice, knowledge, and skill. It is imperative to have a good understanding of various food types that can be used for feeding animals at different times (Portaluppi *et al*., 2010). Moreover, it is likewise important to have basic knowledge about quality (nutritional value) of the feed that is being fed to the animals and different foods that have the right characteristics for mixing them together for making balanced rations for the animals (Khan *et al*., 2021). Silages are considered as an important source of nutrients and carbohydrates for the animals. These can mainly be used for increasing the productivity of animals or increasing the stocking rate, however, the main advantage that can be achieved by feeding silage to the animals is increased animals' production ability. When feeding animals with silage of any kind, the most critical point having effect on the production of animals is the quality of silage (Frame *et al*., 2011). Different grasses and a number of other crops including grains, like alfalfa, Sudan grass, millets, and sorghums, cereal crops including wheat, oat, barley, triticale and rye are used for the purpose of silage making for livestock animals with different nutritional values. These silages when fed to the animals provide different nutrients to animals in varying quantities (Show, 2002). Maize is important crop (Khan *et al*., 2021; Adnan, 2020; Ali *et al*., 2020; Asif *et al*., 2020; Adnan and Bilal, 2020; Wasaya *et al*., 2019) and utilized for making silage, is the most important one that is widely used for silage making around the world due to its richness in sugar contents that make it easy for ensiling. It is widely used in the dairy and beef cattle diets for the reason that it has high energy and dry matter contents as compared to other silages (Lithourgidis *et al*., 2011).

Sunflower is most important oilseed crop of the world (Haq *et al*., 2020), as far as its silage is concerned, it is the most widely used in developed countries of the world for the silage making for the young infants of animals, and in combination with the maize crop plants, it is proved to be the best in the quality and the production of silage with enhanced protein and oil contents (Khan *et al*., 2021). The seed cake of the sunflower plant with mature seeds is abundant in proteins and oils, which increases the production of meat and milk in the animals to about more than 20% as compared to other simple silages and this combination is healthier and digestible for the young ruminants. The proper intervention of both crop types for the enhancement of silage quality is the main parameter for present study and the study will evaluate the feasibility of such combinations in the long-term production benefits, as the farming of cattle's and other livestock animals are concerned (Robson *et al*., 2002; Khan *et al*., 2021). The present study was planned to estimate the combined effect of sunflower and maize crop for the quality production of silage to enhance the growth and production in the animals.

Materials and Methods

Experimental site, design and treatments

The experiment was conducted at research area of College of Agriculture, Sargodha-Punjab, Pakistan during 2016 to evaluate the combined effect of sunflower and maize crop for the quality production of silage to enhance the growth and production in the animals. Experiment was laid out in completely randomized design with three replications. The six varieties of maize used in combination with sunflower

(Hysun-33) were evaluated for the silage quality, and the six varieties of maize were also sown and evaluated separately to compare the quality difference between the different silages. Maize and sunflower were sown at the same time. When reached to maturity, those were harvested, chopped and packed in silos to make silage. Inoculum was sprayed on silage before packing. Following are the six maize varieties (Monsanto-6142, Pioneer-1543, Syngenta-8711, Pioneer-33M15, Monsanto-6103 and Pioneer-32B33). The treatments were T_1: Monsanto-6142 + Sunflower, T_2: Pioneer-1543, T_3: Syngenta-8711 + Sunflower, T_4: Monsanto-6142, T_5: Pioneer-1543 + Sunflower, T_6: Syngenta-8711, T_7: Pioneer-33M15 + Sunflower, T_8: Monsanto-6103, T_9: Pioneer-32B33 + Sunflower, T_{10}: Pioneer-33M15, T_{11}: Monsanto-6103 + Sunflower, T_{12}: Pioneer-32B33.

Data recording

After 40 days of packing, silos were opened and samples were oven dried. The data regarding pH, moisture (%), protein (%), ash (%) and fat (%) were taken by their standard procedures.

pH value

Silage samples were collected from the field and the pH of samples was measured with the help of pH meter in the laboratory. The 100 grams of the sample from each treatment was collected and mixed with 100 mL of distilled autoclaved water. Mixed samples were tested by the pH meter and the values of pH for each sample were noted.

Moisture contents (%)

The fresh samples of the silage were collected and weighed with the help of electric balance in the lab. All of the samples from each treatment and replication were than packed in the paper bags and dried in the hot air oven at the temperature of 70°C for 24 hours and weighted after drying. The percentage weight loss was calculated with the help of formula and the moisture content of each sample was calculated as:

$$\text{Moisture} = \frac{W_1 - W_2}{W_1} \times 100$$

W1= Wt. of Petri dish including sample weight; W2 = Wt. of Petri dish after oven drying.

Crude protein (%)

One gram well grind homogenized sample was taken in Micro Kjheldhal distillation flask. Five grams of digestion mixture were added in the flask. Then 30 ml of concentrated H_2SO_4 was added in the flask. It was placed at hot plate for 3-4 hours until solution became clear. After digestion, it was cooled down and volume was made 250 ml by adding distilled water. Ten milliliter of sample solution was taken in Micro Kjheldhals distillation apparatus. Ten milliliters of 40% NaOH solution was added in it then boiled the whole apparatus through steam. The NH_3 was liberated, condensed and collected in a beaker having 10 ml of 2-4% boric acid solution. Again, two to three drops of 0.1% methyl red indicator were added (Chang, 2010). Titration of the beaker content was done against 0.1 N H_2SO_4 till the light pink color end point. The reading was noted and calculation of the % crude protein (CP) was made by using following formula.

$$CP(\%) = \frac{\text{Vol of 0.1N H2SO4 used} \times \text{Dilut. of sample solution} \times 0.0014 \text{ X } 6.25 \text{ x } 100}{\text{Weight of sample} \times \text{Sample solution used}}$$

Ash contents (%)

The fresh samples of silage were weighted and then dried for 24 hours in hot air oven in the lab, all of the samples were then treated with the combustion method and the remaining ash after the complete combustion was weighed and the percentage ash content was calculated with the formulae of Ukiwe *et al*. (2008).

$$\text{Ash content \%} = \frac{W2 - W1}{\text{sample weight}} \times 100$$

Fat contents (%)

Fat contents percentage of the silage samples was calculated with the Soxhlet Extraction method and the percentage fat contents were calculated as suggested by Eikani *et al*. (2012).

Statistical analysis

The recorded data were subjected to Analysis of Variance (ANOVA) and their means were compared by using least significant difference at 5 % level of significance (Steel and Dickey, 1997).

Results and Discussion

pH value, moisture contents (%), protein contents (%), ash contents (%) and fat contents (%)

The data regarding pH value, Moisture contents (%), protein contents (%), zsh contents (%) and fat contents (%) is presented in Table 1. The pH of the

Table 1: *Evaluation of sunflower-maize silage for yield and quality traits.*

Treatments	pH content	Moisture content (%)	CP (%)	Ash content (%)	Fat content (%)
T1= (Monsanto - 6142 + Sunflower)	3.77 cd	38.66 a	17.41 a	2.88 c	14.99 c
T2= (Pioneer- 1543)	3.73 cde	36.87 b	8.20 h	2.26 de	6.70 e
T3= (Syngenta- 8711 + Sunflower)	4.10 ab	34.23 f	16.31 d	3.16 b	15.54 a
T4= (Monsanto- 6142)	3.87 bc	32.66 g	8.30 gh	2.24 de	5.95 f
T5= (Pioneer- 1543 + Sunflower)	4.21 a	35.72 d	16.99 b	2.98 c	15.00 b
T6= (Syngenta- 8711)	3.47 efg	32.96 g	8.70 e	2.33 d	6.82 e
T7= (Pioneer- 33M15 + Sunflower)	4.13 ab	34.83 e	17.28 a	2.90 c	14.63 d
T8= (Monsanto – 6103)	3.23 g	34.70 e	8.53 ef	2.20 e	5.70 g
T9= (Pioneer – 32B33 + Sunflower)	4.17 a	34.05 f	17.24 a	3.31 a	15.26 a
T10= (Pioneer – 33M15)	3.53 def	36.34 c	8.47 fg	2.24 de	5.80 fg
T11= (Monsanto - 6103 + Sunflower)	4.20 a	34.43 ef	16.74 c	2.92 c	15.00 c
T12= (Pioneer – 32B33)	3.37 fg	35.85 d	8.53 ef	2.20 e	6.70 e

Mean having different letters differ significantly from each other by Least Significance Difference (P=0.05).

silage directly relates to the chemical activity in the silos and the crop contents of the silage. The data of pH showed that treatments differed significantly. The minimum pH value (3.23) was observed with Monsanto-6103 whereas maximum pH value (4.17) was recorded with Pioneer-32B33 + sunflower. The data of moisture contents showed significant difference among the treatments. The analysis showed that the maximum mean value (38.66%) of moisture content was observed with Monsanto-6142 + sunflower and most of combined treatments have moisture level ranging between 35-40% which showed the preserves silage quality and maximum availability of the nutrients to the livestock animals. However, minimum moisture contents (32.96%) were noted with Syngenta-8711. Maximum value of protein content (17.41%) was measured with Monsanto-6142 + sunflower and the minimum protein content (8.20%) was observed with Pioneer-1543. The significant difference of ash contents (%) was observed within the treatments. Maximum ash content (3.31%) in silage was recorded with Pioneer-32B33 + sunflower while minimum ash content (2.20%) in silage was examined with pioneer-32B33. Treatments showed fat contents of up to 25% in the combination of maize and sunflower and showed significant difference between the silages derived from the maize and combination of sunflower and maize. The analysis of variance showed highly significant effect of treatments on the fat contents. The maximum mean value for fat contents (15.54%) was observed in Syngenta-8711 + sunflower while minimum value of fat contents (5.70%) was recorded with Monsanato-6103.

The pH is an important factor in the silage preservation, the low pH silages are best for the long-term preservation and the available nutrients are preserved for longer time period. The low pH silage is also enriched with the nutrients and the fungal growth is not possible at pH lower than 4. The data regarding pH is presented in Table 1. The results of the present study are reinforced by the finding of Ghazali *et al.* (2013), Jalc *et al.* (2009) and Huisden *et al.* (2009), who examined significant effect of various silages on their pH value. Silage pH in pure corn silage and mixture silages that have a high rate of corn were found in low value due to corn containing more dry matter content and soluble carbohydrate (Tan *et al.*, 2015). The moisture contents of the silage contribute to the available nutrients and the silage quality in terms of digestibility and storage limits. The loss of moisture contents in the silage may inhibit the availability of nutrients for the livestock and also decrease the digestibility of the silage especially in young ruminants. Maize silage has 30-45% of the moisture and 35% of moisture level is best for the ideal storage life of the silage. Findings of our experiment are supported by the results of Jalc *et al.* (2009) and Huisden *et al.* (2009). The moisture content of the silage depends on the crop type and the available moisture in the crop, as the maize has elevated amount of moisture content and the sunflower has low moisture contents in the mature seed disc. This combination of the crop types makes a sufficient balance between the moisture contents of the silage providing an ideal moisture level to make the silage preserved from any fungal attack and also aids in the digestibility of the silage nutritional contents.

Protein is one of the most important constituents of the silage and the silages rich in protein contents are more likely to be the best for the livestock growth, especially important in the milk production. The maize silage has very low amount of protein ranges from 8-9%, which is the main requirement of the animals for proper growth and development in the lactation period. All of the treatment combinations of maize with sunflower have maximum protein content up to 30% and economic factors including cost of the silage with comparison of animal output is best fit under this protein dose of maize and sunflower silage. Results of our experiment are in accordance with De-Brouwer *et al*. (1991) and Mafakher *et al*. (2010), who reported differences in terms of CP among different silage types. Maximum CP in Monsanto-6142 + sunflower silage may be due to high crude protein contents of corn as well as sunflower (Tan *et al*., 2015). The ash content shows the mineral contents of the silage, average ash contents within the range of 2-4% is good for the silage quality, low quantity of the ash content shows poor quality of the silage and the value more than 5% shows the possible soil composition problem and such type of silage are not so good for the digestion especially in the young ruminants. Increase in ash contents of mixed silage is due to more nutrient uptake from soil and accumulation in their tissues of corn and sunflower (Mafakher *et al*., 2010). Fat is the important content of the silage and determine the silage quality in a broader spectrum, as the maize crop had just only 7% of fat contents which is not sufficient for the high-quality silage and also not fit for elevated growth in the livestock. The sunflower seeds and disc have more than 40% of oil contents which in combination with the maize crop gives significance level of fat contents in the silage (Cox *et al*., 2006). The elevated fat contents contribute to increased growth rate in the livestock especially in the young ruminants, the growth rate in terms of meat was significantly affected by the daily intake of oil contents in feed. The combination of the sunflower with maize elevated the amount of oil in the nutritious value of the silage and its outcomes in terms of milk and meat production. The increase in fat contents of corn and sunflower mixed silage is due to addition of sunflower grins which are rich in protein and oil contents. These findings are in accordance with Mafakher *et al*. (2010), who reported improvement in quality of corn sunflower mixed silage.

Conclusions and Recommendations

After the complete evaluation of above-mentioned quality parameters, the estimated best combination for the combined silage of maize and sunflower head is Monsanto and Syngenta with the sunflower head, as both of the varieties have better results for the protein and fat contents.

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Novelty Statement

Silage is the term used for forage with a high moisture content preserved by fermentation. The main objectives of making silage are to preserve forage for use in those seasons when fresh forage is not available, to preserve forage when there is a surplus of it during the growing season, and to preserve forage that cannot be grazed.

Author's Contribution

Zain Ali and Amjed Ali: Helped in concept, design and literature search of experiment.
Bilal Ahmad Khan, Muhammad Adnan and Muhammad Ehsan Safdar: Helped in statistical analysis.
Muhammad Asif and Muhammad Ather Nadeem: Helped in manuscript preparation.
Muhammad Imran: Helped in manuscript editing and review.

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Conflict of interest
The authors have declared no conflict of interest.

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