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Review on Crucial Parameters of Silage Quality

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Abstract

The main objective of this review is to investigate the effects of temperature of fermentation environment, chopped length of the forages and fermentation period on the quality of silage. The problem in this agricultural research industry is that there is a lack of interest in doing the investigation by cross-relating other available knowledge in this field. Fermentation process of silage can also apply the concept of chemical processing by investigating the parameters related to the process, like those mentioned above. From this review, it was found that temperature and chopped length do not significantly affect the quality of silage produced but the fermentation period must be considered as a crucial parameter. Recommendation is that further investigation on fermentation period by different type of forage must be considered and the effect of additive on the completion of fermentation process must also be investigated in order to save time, cost and to optimize nutrient content in silage.

Keywords: Chopped Lengths, Fermentation period, Silage, Temperature

1. Introduction

Normally each country feeds their cows differently and the same applies to Malaysia. Thus, it is essential to suggest new formulation for cow's feed that is suitable with Malaysia's environment. Malaysia Agriculture and Agro Department is aware that Malaysia has to minimise dependence on imports of livestock feed and should lessen the impact of the global food crisis by 2020 (1). Therefore, the cow feed industry in Malaysia really needs more improvements.

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In European countries like Netherland, Germany and Denmark, ensiled forages are highly valued as animal feed. More than 90% of the forages such as maize, grasses, legumes and wheat are locally produced and stored as silage (2).The ensiling process is a preservation of moist forage crops under anaerobic condition to enhance the nutrient content. As a result, pH will decrease and the moist forage is preserved from spoilage microorganisms. The technique is safe and easy to use; does not pollute the environment; and the products are regarded as natural products (3). Currently in Malaysia, some farmers do realize about the advantages of using silage as the main feed. However, the technology still cannot convince other farmers to use silage instead of other types of cow feed. In order to preserve the nutritional quality of the silage, certain essential conditions need to be met during the storage process. Roughly speaking, the factors are like the stage of maturity of the forage at harvest and the type of fermentation that occurred in the silo or bunker which will slightly affect the quality of the silage product. In detail, the forage used must have high concentration of water soluble carbohydrates (WSC); low buffering capacity; and dry matter (DM) content of about 250-400g/kg for proper ensiling process (4). Higher residual of WSC content indicates smaller DM losses during fermentation and produces better silage. In chemical processing perception, parameters related to the ensiling/fermentation process must also be considered, for example temperature, air content, chopped length of forages, fermentation period, moisture content and pH. Thus, the main objective of this review is to investigate the effects of temperature of fermentation environment, chopped length of the forages and fermentation period on the quality of silage produced through reviewing some research done in this field.

2. Effects of Temperature during Fermentation on Silage Quality

The success of fermentation of silage is closely related to the environment during the process. Therefore, it is important to determine how temperature will control the silage quality produced. Table 1 shows some investigations on various type of silage product (9, 10, 4, 3, 11, 12, 13, 14, 15). The temperature used is almost significantly different from each other. Commonly, ambient temperature was used and this might be caused by the fact that the researchers wanted to make the process easier and faster and also to save energy and equipment. These assumptions will not be further investigated and clarified in this review. Based on the research results, temperature affects the performance of microbiology additive used such as Lactic Acid Bacteria (LAB) in the ensiling process. Without any additive, well-fermented silage was obtained at 40°C because higher temperature depressed the activities of microorganisms as it was unfavorable for silage fermentation but with LAB additive, the quality of silage was reduced even if fermented at 40°C because LAB would be killed under high temperature (5). Other additive used like sardine waste is also highly dependent on the temperature of fermentation process. From present day studies, ensiling of sardine waste as additive can be realized at ambient temperature at several areas of the world but with different pH of silage produced (6). It can be concluded that the temperature of ensiling process will affect the quality of silage due to the additive used in the silage.

3. Effects of Chopped Length of Forage on Silage Quality

The effect of chopped length size on silage had been poorly investigated and most studies were performed using precisely chopped crops. Similar to the human digestion system, chopped or chewed food will help the digestion system to absorb nutrient from that food more efficiently in the intestinal track. Some research that have been done in the silage field are presented in Table 1, it should be noted that the effect of chopped length was not taken seriously by researcher (9, 10, 4, 3, 11, 12, 13, 14, 15). Most researches were carried out as long as the forage was chopped. Unchopped silage can be attributed to long awns associated with grain. It will increase fiber concentration and reduce feed intake and performance of cattle, especially young cattle (7). The

chopped length also has a significant relationship with maturity of the forage harvested. Chopped length does not induce large difference in starch particle size distribution at the early maturity state. Late harvest of unchopped forage will give lower starch ruminal digestion (8). The size of forage chopped will give high impact on the effectiveness of the silage formulated. Besides that, it also depends on the type of forage taken as a raw material. By comparing grass and straw, the texture of the plant is different and thus gives different digestibility. Meaning to say that if the chopped length of grass is larger than straw, it will possibly give the same effectiveness in the digestion system of a cow.

Table 1. Comparison of Temperature, Chopped Length and Fermentation period used in Various Type of Silage

Type of Silage	Temperature *(K)*	Chopped Lengths (*cm*)	Fermentation Period *(day)*	Crude Protein Content *(%)*	
				UTS	TS
Rice Straw (9)	35	0.7	3-5	4.2	7.2
Maize (10)	20	1	60	9.8	10.4
Potato Skins (4)	24-28	-	90	10.7	13.9
Wheat (3)	23-27	1.5	65	13.8	NF
Sorghum Straw (11)	ambient	0.2	60	7.6	8.19
Potato Hash (12)	22-25	-	90	16.4	17.1
Grass (13)	21	-	105	12.6	14.7
Ruzigrass (14)	27-30	2-3	45	4.94	5.02
Italian Ryegrass (15)	24	-	60	12.3	12.1

UTS; untreated silage, TS; treated silage

4. Effect of Fermentation Period on Silage Quality

Quality silage is achieved when the fermentation process completed well. It occurs when lactic acid is the predominant acid produced, and thus will drop the silage pH quickly. The faster the fermentation is completed, the more nutrients will be retained in the silage (16). From Table 1, most of researchers used 60 days fermentation period (9, 10, 4, 3, 11, 12, 13, 14, 15). Rice straw gave the lowest fermentation period and the protein content was also the lowest because the carbohydrates did not complete the degradation process yet. The others just took extra days to ensure the fermentation process was completed. It shows that fermentation period is a crucial parameter in producing good silage. The mechanisms of fermentation process must be investigated well to ensure that the fermentation period chosen can complete the process. Table 2a (2) and 2b (16) present the two different mechanisms occur in fermentation process as disclosed by two different research. Table 2a shows four phases of fermentation process including aerobic, fermentation, stable and feed out. Table 2b gives more detailed information which categorizes the fermentation process into six phases. Both investigations look similar but the important point here is that each phase must be completed and handled well to get good silage. The critical time during the ensiling process and how many days will it require for the full completion depend on the type of silage and additive used. Normally, 60 days of fermentation period will make it safe, but the effect of longer or shorter fermentation must also be considered to save the time, cost and optimize the nutrient content in the silage.

Table 2a. Silage fermentation stages and their mechanisms

Stages	Phases name	Time taken	Mechanisms
1	Aerobic	A few hours	Atmospheric oxygen present between the plant particle reduced due to respiration
2	Fermentation	Several days/weeks	LAB develop and become predominant
3	Stable	As long as air prevented	Most microorganisms decrease
4	Feed out/ Aerobic Spoilage	Starts as soon as silage exposed to air	Process of spoilage started by yeast, temperature change and activity of spoilage microorganisms

Table 2b. Silage fermentation stages and their mechanisms

Stages	Phases name	Time taken	Mechanisms
1	Aerobic	2 days	Breakdown of plants protein and reduce to amino acids
2	Anaerobic fermentation	2-3 days	Growth and development of acetic acid
3	Brings Phase 2 to and end	3-4 days	Enhances the growth and development of anaerobic group of bacteria and produces lactic acid
4	Lactic acid formation	4-21 days	Lactic acid begin to increase until pH is low enough to inhibit growth of bacteria
5	Material Storage	21 days	Large population of bacteria may grow and produce butyric acid instead of lactic acid
6	Aerobic decomposition	Starts as soon as silage exposed to air	High population growth of yeast or mold. Proper management is vital

5. Conclusion

The problem occurs in the related agricultural industry is a lack of interest in doing the investigation by cross-relating other knowledge in this field. The fermentation process of silage can also apply the concept of chemical processing by investigating the parameters related to the process like temperature, chopped length of the forage and fermentation period. From this review, temperature and chopped length are less significant in determining the quality of silage produced but the fermentation period is a crucial parameter. Thus, it is recommended that further investigation on fermentation period taken by different types of forage must be considered and the effect of additive also must be investigated.

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