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Report for Happy Horse Products Ltd.

An investigation into the pollution (Biological Oxygen Demand) caused by disposal of water following soaking hay to feed to horses and a comparison with the waste water from the Happy Horse Haysteamer.

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Abstract

It is an established fact that of all forage sources hay is most likely to contain high numbers of dust particles. Removal of these particles can be carried out in a number of ways including soaking and steaming, however there is concern about the amount of pollution contained in waste water from these processes. In the present study, hay was soaked and steamed for various time intervals, the waste water was collected and biological oxygen demand was determined. Results showed that waste water from steaming hay had significantly lower biological oxygen demand than waste water from soaking hay ($P<0.001$). Steaming hay is therefore likely to be less polluting than soaking hay.

Contents

1.0 Introduction

It is an established fact that of all forage sources hay is most likely to contain high numbers of dust particles (Robinson *et al.* 2001) and may therefore increase the likelihood of chronic obstructive pulmonary disorder (COPD) or other respiratory problems occuring (Harris, 1999). Soaking hay is a long-established practice which has been used from as early as 1656, when Markham wrote "the best cure for broken wind is grass in the summer and hay sprinkled with water in winter." More recently studies have been carried out to determine the benefits of soaking hay for a variety of animals (Clements and Pirie, 2007; Rymer, 2008). Steaming hay is an area which has not been widely researched despite there being several products available on the market for public use, it is therefore vital that research is undertaken to evaluate the use of these products in the industry.

1.1 The Benefits of Soaking Hay

Moore-Colyer (1996) suggested that the number of dust particles in hay can be reduced by up to 90% when hay was soaked for 30 minutes. The same study reported that there were no more significant reductions for soaking hay for up to 12 hours. In addition, soaking hay has been shown to decrease nutritive value (Warr and Petch, 1992) and therefore soaked hay may be fed to horses which require a restricted calorie intake. Laminitic horses may also benefit from being fed soaked hay as on average 31% of non-structural carbohydrates are leached from hay during 60 minutes of soaking (Watts, 2004).

Soaking hay does have one major drawback though which is related to the waste water left at the end of soaking. The biological oxygen demand of the waste water is high enough that it gives rise to concerns regarding pollutants leaching into the environment (Clements and Pirie, 2007). It is therefore important to explore new ways of achieving the same benefits of soaking hay but minimising the risk to the environment, one such method is steaming.

1.2 The Benefits of Steaming

Steaming has been shown to increase the digestibility of forage sources such as barley straw, pea straw and bagasse by 16%, 15% and 22% respectively, by decreasing the amount of hemicellulose present (Ibrahim and Pearce, 1983). This suggests that an animal is likely to gain more nutritional value from these forages in a steamed state as opposed to a natural state. Similarly when alfalfa hay is steamed it has been found that protein digestibility increases in dairy cows (Broderick *et al.* 1993).

In addition to research into the benefits of steaming being limited, there is also little evidence to suggest whether the pollutants from waste water from steaming are as detrimental to the environment as the pollutants from soaking and it is therefore vital that such research is undertaken as steaming products become more popular.

1.3 Biological Oxygen Demand

Biological oxygen demand is a measurement of how much oxygen is used by bacteria, when consuming decomposable organic matter. It is the difference between the starting oxygen level and finishing oxygen level after five days incubation at 20°C. Waste water contains high levels of decomposable organic matter, and therefore bacteria use more oxygen for decomposition than in water which has low levels of pollution and hence low levels of organic matter. The EU states that the upper biological oxygen demand limit for waste water is 3mg/litre for drinking water – this water would require only chlorination treatment before being used for consumption. A biological oxygen demand of 5mg/litre is considered to be normal for waste water and 7mg/litre is considered to be high and therefore requires additional treatment (NWRC, 2003).

1.4 Aims and Objectives

The primary aim of the study was to determine the biological oxygen demand of the waste water from soaking and steaming hay. The secondary aim was to determine whether the amount of time spent soaking or steaming affected the biological oxygen demand. The objectives were to quantify biological oxygen demand of waste water from soaked and steamed hay by taking waste water samples at different time intervals.

2.0 Materials and Methods

The study was designed to measure differences between biological oxygen demand of the waste water from soaking and steaming hay. It was also designed to determine differences between biological oxygen demand after different soaking and steaming time intervals.

2.1 Hay Source

The hay used in the study was grown and cut at Myerscough College in summer 2008. The hay did not receive any rainfall in the five days between cutting and baling. Once baled the hay was stored in an open fronted barn until the start of the study. The bales used in the study were chosen at random from the stack in the barn. One kilogram of hay (equivalent to approximately one slice from a small bale) was used for each separate steaming or soaking trial in a small holed haynet.

2.2 Steaming Method

The hay steamer used in the study was the Happy Horse© hay steamer. The steamer requires seven litres of water to fill it to maximum capacity. The water was heated for 20 minutes according to the manufacturer's guidelines, and then a single haynet was placed inside the steamer. Ten repetitions were done in total. Waste water was collected from outlets in 250ml plastic containers. The plastic containers were changed at intervals of 10, 30, 60 and 90 minutes and the oxygen content of waste water in the containers determined using an oxygen sensor.

2.3 Soaking Method

Each haynet was soaked in an individual clean bucket, in 14 litres of cold water (this was found to be enough water so that the top of the haynet was covered). Ten repetitions were done in total. Samples of water were taken from the buckets at intervals of 10, 30, 60, and 90 minutes and the oxygen content determined using and oxygen sensor, for comparison to the steamed hay. The hay was then left soaking and further samples were taken at 3, 6 and 9 hours to determine the effects of prolonged soaking.

2.4 Biological Oxygen Demand Analysis

The waste water was transferred to a labelled glass-stopper bottle and placed in an incubator at 20°C for five days. The same oxygen sensor was used to measure oxygen content of the samples. The final reading was then subtracted from the original value for each sample in order to determine the amount of oxygen which had been used in oxidation of pollutants and hence the biological oxygen demand.

2.5 Statistical Analysis

A Kruskal Wallis test was used to detect differences between the BOD values for steamed and soaked hay. ANOVA was used to detect differences in BOD values at different time intervals. Significance was determined at the $P<0.05$ level.

3.0 Results

The results were analysed in terms of treatment type and treatment time. A significant result was found between the BOD values for the waste water from soaked and steamed hay ($P<0.001$).

3.1 Treatment Differences

Figure 3.1.1 shows the mean differences in BOD values for the waste water from soaked and steamed hay. When analysed using a Kruskal-Walis test it was found that there was a significant difference between these values ($P<0.001$), suggesting that the waste water from the soaked hay had a larger BOD value than the waste water from the steamed hay.

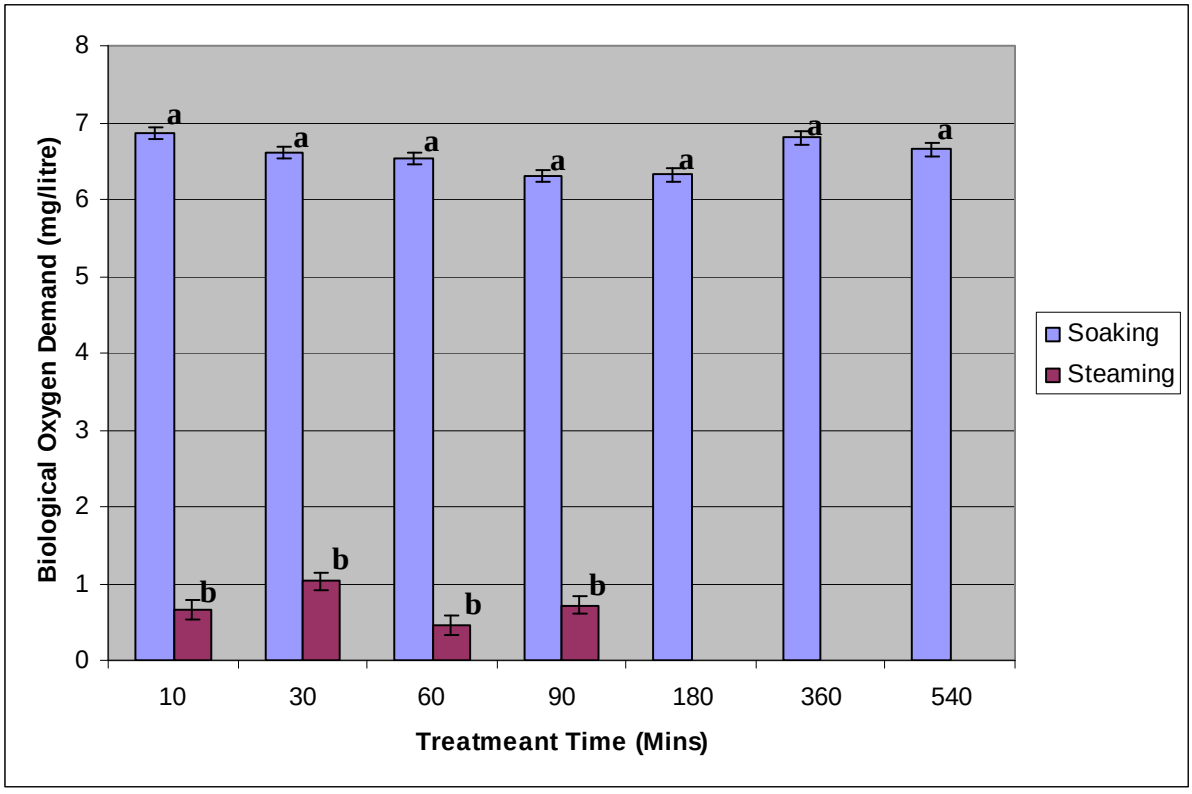

Figure 3.1.1 - Mean Differences in BOD levels of waste water from soaked and steamed hay at various time intervals (letters denote heterogeneity at P>0.05 level)

3.2 Effect of Time Interval

Figure 3.1.1 illustrates the mean differences in BOD values at various time intervals. When analysed using ANOVA, it was found that there was no significant differences between BOD values obtained at each interval for either the soaked or the steamed treatment group ($P>0.05$). This suggests that there are no differences in pollution levels of the waste water from steaming and soaking hay.

4.0 Discussion

Hay steaming as opposed to soaking significantly reduced the biological oxygen demand of waste water from each process. This indicates that the steaming process produces water which is less polluting than the soaking process.

Soaked hay produced waste water with a biological oxygen demand of up to 6.86 ± 1.11 mg/litre, a level considered to be highly polluted and similar to levels in rivers upstream of a sewage outflow. In relation to the actual biological oxygen demand values for steaming, mean biological oxygen demand varied from 0.45 ± 0.31 mg/litre to 1.03 ± 1.19 mg/litre. In comparison to EU regulations, these figures suggest that there is very little pollution in the waste water and therefore the water would need minimal chlorination treatment in order to be made safe for consumption. With regards to leaching into rivers and waterways of the waste water from steaming, the BOD values suggest that the waste water has a low biological oxygen demand, and would not be considered a threat to organisms in the environment (NWRC, 2003).

Results indicated that there was no change in the biological oxygen demand of the waste water for either soaked or steamed hay with increasing time intervals. This suggests that there was no increase in the pollution that was removed from the hay after the first ten minutes. A similar study by Moore-Colyer (1996) showed that there was no benefit to

soaking hay beyond twelve hours in terms of removing dust particles. This is supportive of the current research.

Overall it has been found that steaming hay appears to be the most environmentally sound method of removing dust particles from hay, whilst minimising the pollution that is removed with the waste water. Further study is now required to determine the nutritional benefits of steaming hay in comparison to soaking.

5.0 References

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