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# Effect of Grazing Muzzles on the Rate of Pelleted Feed Intake in Horses

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# Accepted Manuscript

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1 **Effect of grazing muzzles on the rate of pelleted feed intake in horses**

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9

10 **ABSTRACT**

11 Esophageal obstruction or “choke” is a relatively common occurrence in the equine industry. It  
12 often results from improper mastication, consuming feed too quickly, dehydration or a decrease  
13 in saliva production. Esophageal obstruction is a medical emergency during which a horse  
14 cannot dislodge a bolus of feed from the esophagus and must wait for human intervention o rfor  
15 the block to be softened and moved by peristalsis. This condition may result in the formation of  
16 ulcers, esophageal rupture, aspiration pneumonia, and possibly death. Grazing muzzles have  
17 been shown to slow the rate of forage intake. We hypothesized that grazing muzzles could also  
18 be used to decrease the rate of pelleted feed intake and so possibly reduce the risk of equine  
19 esophageal obstruction in horses fed large meals of pelleted feed. The objective of this research  
20 was to compare the rate of pelleted feed intake for horses wearing grazing muzzles to those  
21 wearing no muzzle. Utilizing a crossover design, horses were randomly assigned to three groups  
22 with each horse receiving each treatment. Treatments were as follows: No Muzzle (NM), Easy  
23 Breath Grazing Muzzle (EBGM), or Tough 1 Nylon Grazing Muzzle (TNGM). Eight adult  
24 stock-type horses age  $5 \pm 1$  years, were offered 2.27 kg of pelleted concentrate to consume in a  
25 10-minute period once daily. The study was comprised of three periods (5 days each) with a two-  
26 day resting period between each. Horses were weighed daily and no significant change in  
27 bodyweight was observed. Data for daily intake were analyzed using the PROC MIXED  
28 procedure of SAS with significance established at  $P < 0.05$ . Both the EBGM and the TNGM  
29 reduced rate of intake ( $P < 0.05$ ) during a 10-minute feeding interval as compared with NM. The  
30 findings of this study revealed that grazing muzzles may be a viable option to reduce the rate of

31 intake of pelleted feed, which may benefit horses susceptible to choke as a result of rapid feed  
32 ingestion.

33

34 **Keywords:** “choke”, equine, grazing muzzle, feed intake

35

36

## 37 **INTRODUCTION**

38 Equine esophageal obstruction, or “choke”, is a dangerous condition and the most  
39 common source of esophageal complications (Duncanson, 2006). Choke occurs when a bolus of  
40 foodstuff becomes lodged in the esophagus and must be removed either through the action of  
41 salivary lubrication, which is often inadequate, or human intervention (Hillyer, 1995). Choke is  
42 generally a result of improper or inadequate mastication, consuming pelleted feed too quickly  
43 (bolting), or insufficient salivary production (Kobluk et al., 1995). Signs of esophageal  
44 obstruction include dysphagia, excessive drooling, nasal drainage, coughing, halitosis, spasms of  
45 the neck muscles and repeated swallowing (Hillyer, 1995). In addition, there may also be a  
46 visible mass in the throat area. Esophageal obstruction blocks the esophagus and prevents the  
47 passage of feed and liquid and, if present for long periods of time, can cause permanent damage  
48 to the esophagus. Damage due to choking includes esophageal ulcers, impaction colic, aspiration  
49 pneumonia, and potentially death (Kobluk et al., 1995). Treatment for choke is problematic as it  
50 involves insertion of a tube down the afflicted horse’s throat and flushing out the bolus. This  
51 procedure can cause additional trauma to the esophagus and, in severe cases, surgical removal of  
52 the bolus may be necessary (Hillyer, 1995).

53 Since a majority of choke incidents are caused by rapid intake of feedstuff, decreasing the  
54 rate of intake and encouraging proper mastication is critical to prevent choke (Frape, 2008).  
55 Many horse owners utilize grazing muzzles to slow the intake of forages (Glunk et al., 2014;  
56 Longland et al., 2011). We hypothesized that grazing muzzles could also be used to decrease the  
57 rate of pelleted feed intake and possibly reduce the risk of equine esophageal obstruction. The  
58 objective of this research was to compare the rate of pelleted feed intake for horses wearing two  
59 different types of grazing muzzle with those wearing no muzzle.

60

## 61 **METHODS**

62 Institutional Animal Care and Use Committee (IACUC) approval was obtained prior to  
63 the initiation of this study. All research was conducted at Southern Illinois University Equine  
64 Center, Carbondale, Illinois. Eight Southern Illinois University-owned horses, two geldings and  
65 six mares, age  $5 \pm 1$  years (mean  $\pm$ SD), and with a bodyweight of  $491 \pm 35$  kg (mean  $\pm$ SD),  
66 current with vaccinations and in good dental health were used. The grazing muzzles included,  
67 the Easy Breathe Grazing Muzzle (EBGM; JT International Distributors, Inc., Indianapolis,  
68 Indiana) and Tough 1 Nylon Grazing Muzzle (TNGM; JT International Distributors, Inc.,  
69 Indianapolis, Indiana). The EBGM has a single central rectangular opening with an area of 6.35  
70 cm. The TNGM has a single circular opening with an area of 1.99 cm.

71 Prior to the start of this study, horses were acclimated to both muzzles for one week by  
72 wearing them during normal morning feeding. Horses were randomly assigned to treatment  
73 groups with data collection occurring during three periods (5 days each) with a two-day resting  
74 period. The study was designed such that the third and final period served as the control for all  
75 eight horses. This was done in an effort to prevent negative associative behavior that may arise  
76 with daily muzzle use. Authors were concerned that the horses would become “trained” to the  
77 muzzles and would delay eating until the muzzles were removed. Prior research has  
78 demonstrated that horses are adept at learning and can discriminate between new stimuli with  
79 very few reinforcements needed (McCall, 1990). Additionally, the horses utilized for this study  
80 had been recently cecally-cannulated (90 days  $\pm$ 1) utilizing a two-stage surgical technique  
81 (Beard et al., 2011) and the authors wanted to be certain that all control measurements were  
82 collected simultaneously in order to ensure that the surgical healing process was similar across  
83 treatments. The adaptation of this randomized, crossover design was utilized with a repeated  
84 measures component such that each horse would provide data in each period and would receive  
85 each treatment (Vonesh and Chinchili, 1997).

86 At the start of each period, each horse was removed from grass pasture at approximately  
87 1600 hours and placed in separate identical 3×4 meter stalls with *ad libitum* access to water and a  
88 salt block. Each horse was offered 2.27 kg of pelleted grain (Strategy<sup>®</sup> Purina Animal Nutrition  
89 LLC, Shoreview, MN) and 2.27 kg of mixed grass hay. At approximately 2200 hours, the hay  
90 was removed from the stalls and horses were weighed using a digital livestock scale. Horses  
91 were fasted overnight in order to ensure adequate appetite for the morning meal. At  
92 approximately 0600 hours, the horses were offered 2.27 kg of pelleted feed in 68-Liter, oval pans

93 (Tuff Stuff Products, Terra Bella, California) for a 10-minute feeding interval. Following the  
94 completion of the 10-minute feeding interval, feeding pans were removed from the stall.  
95 Spillage and orts were measured in order to calculate total consumption. The horses were then  
96 allowed to finish any uneaten portion (as required for IACUC compliance) prior to being turned  
97 out to pasture for the day. Air temperature was taken every morning at 0600 hours.

98 Data were analyzed using SAS version 9.4 (Cary, North Carolina). Each treatment had  
99 eight horses except TNGM, which had seven horses due to an unrelated health issue in a single  
100 horse. Consumption data were analyzed as repeated measures (Littell, et. al., 1998) using the  
101 MIXED procedure of SAS (Cary, North Carolina) with significance established at  $P < 0.05$ .  
102 Spillage data were analyzed using the PROC NPAR1WAY procedure of SAS with the  
103 Kolmogorov-Smirnov test to check for significance between treatment groups.

104 Consumption data are reported as the differences of least square means with fixed effects  
105 of horse, time, treatment, and treatment\*time analysis using a Tukey's post-hoc test to test for  
106 significance between each group. Spillage data are reported as means per morning feeding  
107 event.

## 108 **RESULTS**

109 Both the EBGM and the TNGM grazing muzzles caused a decrease ( $P < 0.001$ ) in rate of  
110 pelleted feed intake during the 10-minute feeding interval as compared with the NM treatment  
111 (Figure 1). Although there was no effect of day ( $P > 0.05$ ), there was an effect of treatment\*day  
112 ( $P < 0.05$ ). The authors have concluded that this interaction effect may be the result of a  
113 behavioral artifact associated with the NM group and their reduced intake on day 1. Student  
114 observers reported that the horses appeared to be standing and waiting to begin eating. This  
115 unexplained behavior was isolated to day 1 and all horses appeared to resume normal intake  
116 behaviors for the remainder of the period. In addition, horses wearing the TNGM appeared to  
117 increase their rate of intake over time, such that by the fifth day of the period, intake was not  
118 different from that of the NM group (Figure 2). This suggests that the horses may have been  
119 learning to manipulate the muzzle. Mean air temperature was reported as  $19 \pm 2.1$  °C and was  
120 considered seasonally typical. Thus, the authors do not attribute any change in intake to  
121 temperature fluctuation (NRC, 1981).

122 Spillage was also affected by treatment (Figure 3). The EBM group had greater spillage  
123 amounts and a greater number of spillage incidents as compared to TNGM or NM ( $P < 0.05$ ).

124 Although the reason for the difference in spillage is unclear, it may be related to the design  
125 differences between the muzzles. Notably, the EBM features a larger central opening.

## 126 **DISCUSSION**

127 Ingesting feed too quickly, bolting, or improper mastication are common causes of choke.  
128 Grazing muzzles are commonly used to reduce forage intake rates (Glunk et al., 2014; Longland  
129 et al., 2011). This is accomplished through slowing the consumption of forage by restricting the  
130 amount a horse can ingest (Longland et al., 2011). Utilization of a grazing muzzle while feeding  
131 pelleted feed was shown to reduce intake rate in this study. Subsequently, this may reduce the  
132 potential for esophageal obstruction and related injuries. Potential pitfalls regarding the use of  
133 grazing muzzles include a potential in increased feed waste and insufficient time to complete the  
134 meal. These may be overcome by the use of a taller feeding pan and by allowing greater time for  
135 meal consumption.

136 Some work has been done identifying the impact of different feeding systems on rate of  
137 intake for both hay and grain. Wasting forage due to improper storage combined with losses  
138 during feeding (spillage) has led to over 40% of forage being lost (Belyea et al., 1985). In a  
139 previous study, feeders with molded cups at the bottom of a bucket were utilized to slow horse  
140 consumption of grain (Carter et al., 2012). The same study also found these feeders reduced  
141 grain spillage and waste.

142 Although horses may be naturally designed to consume small meals throughout the day,  
143 grazing time and pasture intake appear to be inversely related (Siciliano et al., 2012). Thus,  
144 other alternatives must be explored that may provide solutions to inappropriate acceleration in  
145 consumption. Hay nets are another option that can be used to slow the rate of forage intake and  
146 come in a variety of sizes. Rate of intake may be affected by selection based on size of the  
147 openings. In a recent study, the use of small and medium-sized hay nets extended the total time  
148 of forage consumption when used to feed adult horses (Glunk et al., 2014). The length of feeding  
149 time closely resembled the natural foraging time of feral horses. Additionally, grazing muzzles  
150 are frequently used to hinder mass consumption of forage. Overall, researchers have found that  
151 horses can easily adapt to new feeding systems with short acclimation periods (Artistizabal et al.,  
152 2014; Carter et al., 2012; Glunk et al., 2014).

153 Although both muzzles reduced rate of intake, the horses wearing the EBM recorded  
154 greater spillage while eating. In order to address this problem, owners should use taller feed  
155 pans or incorporate a mechanism for catching spilled grain so that waste is minimized.

156 In conclusion, given a one-week acclimation period, horses can adjust to a feeding  
157 regimen that incorporates a grazing muzzle. The grazing muzzle has been shown to reduce rate  
158 of pelleted feed intake and may mitigate the incidence and effects of choke. Further work is  
159 needed to identify the frequency with which owners may utilize grazing muzzles and still  
160 maintain reduction in pelleted feed intake rates. Future projects should consist of longer  
161 treatment periods with longer feeding intervals in order to identify effect of frequency and  
162 longevity of use associated with use of grazing muzzles. Additionally, a closer examination  
163 should be given to the type of muzzle best suited for pelleted grain to minimize spillage.

164

#### 165 **CONFLICT OF INTEREST**

166 None of the authors of this original research have any declared financial interest. No conflict of  
167 interest of either a financial or personal nature is reported.

168

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171 University. No external sponsors participated in its funding.

172

#### 173 **ETHICAL APPROVAL**

174 Institutional Animal Care and Use Committee (IACUC) approval was obtained prior to initiation  
175 of this study.

176

#### 177 **AUTHORSHIP**

178 The idea for the paper was conceived by Dr. Erin Venable. The experiments were designed by  
179 Dr. Erin Venable. The experiments were performed by undergraduate and graduate students  
180 named as co-authors on this manuscript. The data were analyzed by Dr. Erin Venable and  
181 Stephanie Bland. The paper was written by Dr. Erin Venable, Michael Halpin, and Stephanie  
182 Bland

183



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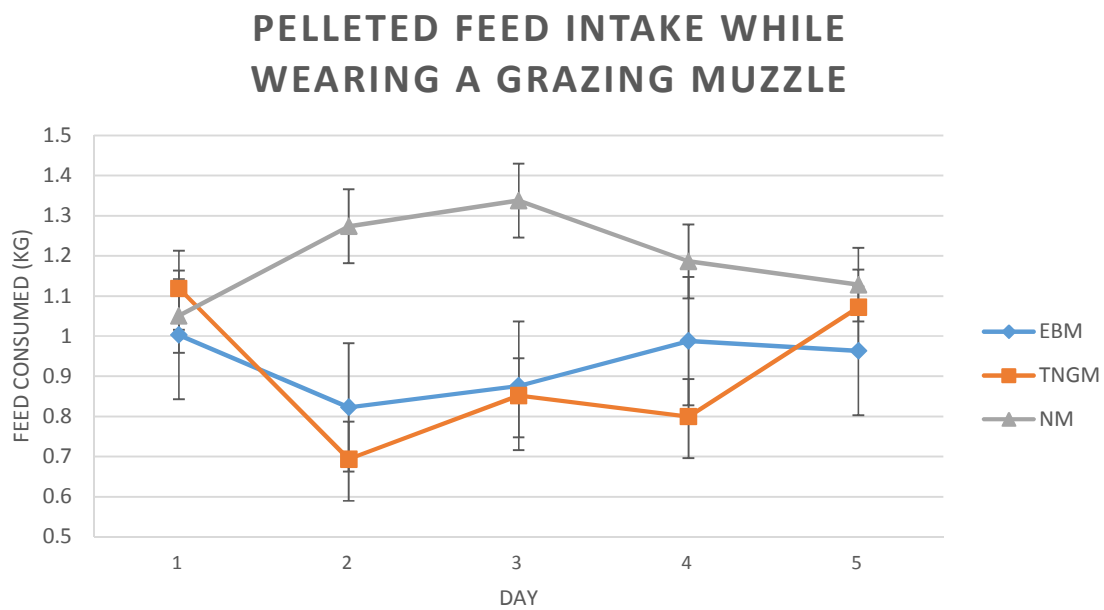
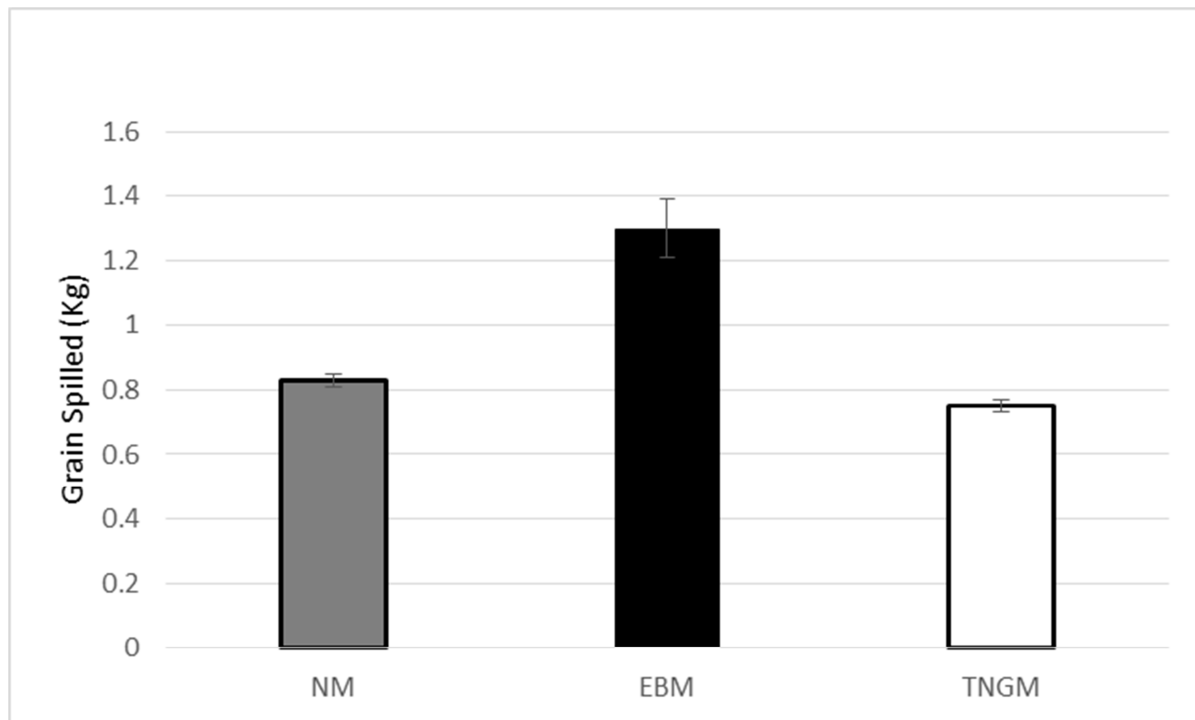


Figure 2. Consumption of pelleted feed intake during a ten minute interval while wearing No Muzzle (NM), Easy Breathe Muzzle (EBM), and Tough One Grazing Muzzle (TNGM) over time.

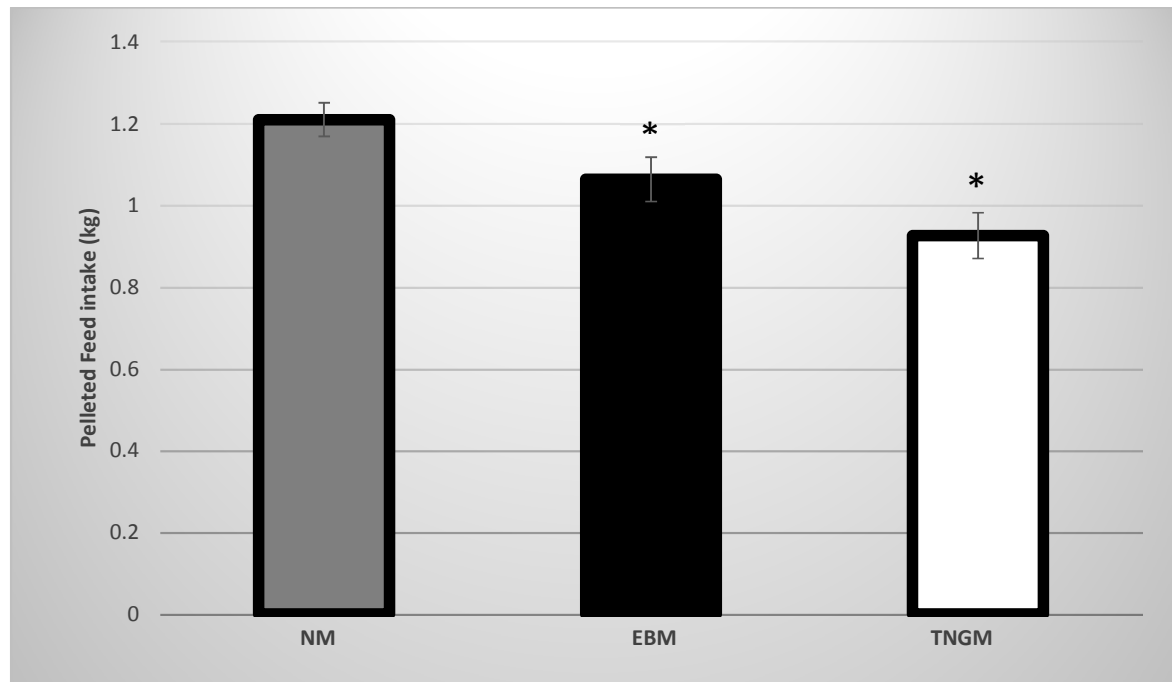


*\*Means differ among groups ( $P < 0.05$ )*

Figure 3: Effects of No Muzzle (NM), Easy Breathe Muzzle (EBM), and Tough One Grazing Muzzle (TNGM) on pelleted feed spilled (kg) during a ten minute feeding event.

\*

\*



\*Means differ among groups ( $P < 0.05$ )

Figure 1: Effects of No Muzzle (NM), Easy Breathe Muzzle (EBM), and Tough One Grazing Muzzle (TNGM) on pelleted feed intake (kg) consumed in a ten minute feeding event.

**HIGHLIGHTS**

We examined the change in rate of intake between two different grazing muzzles.

Grazing muzzles have been demonstrated to reduce the rate of intake for horses consuming forage in pasture.

Grazing muzzles can be used to slow the rate of intake of pelleted feed.