LOADING ACCURACY OF TOTAL MIXED RATION COMPONENTS AS A DIGITAL TOOL ENSURING THE OPTIMAL BREEDING CONDITIONS AND WELFARE IN DAIRY FARMING

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Abstract
The paper is focused on the total mixed ration and it's components, which are used in order to create the best possible mix of ingredients for the feeding of dairy cows. For the experiment a mixer feed wagon with an external loader was selected from an agricultural holding in the Slovak Republic. The total mixed ration consisted of five components, delivered to the wagon via the external loader. The loading accuracy was calculated and evaluated from the extracted data from the wagon's own data software. The data shown there were found some significant differences in the loading of these five components. The average loading accuracy of the TMR was 99.23 %.

Key words: *data digitalization, loading accuracy, mixerfeed wagon, total mixed ration, dairy cows*

INTRODUCTION

The total mixed ration (TMR) is a feeding system, used to provide consistent feed to animals and to stabilize rumen conditions as desired. Feeding activities have an important place in terms of animal health, performance, milk yield or meat production. The very each mouthful of the mixture consumed by an animal, must be homogenous and balanced, otherwide the animal can be negatively affected (*Sova et al., 2014*). Several manufacturers have introduced automatic feeding systems (AFS) during the past decade (*Belle et al., 2012; Unal & Kuraloglu, 2015*). The main advantage of the AFS is the possibility to supply a total mixed ration (TMR) with a high frequency and a low labour requirement, whilst farms which feed with conventional feeding systems (CFS) commonly supply TMR only once or twice a day and require more labour with a rigid work schedule. (*DeVries et al., 2005*). TMR production is formulated to obtain a homogeneous and balanced ratio of all components in one solution. Many strategies can be used in TMR systems. These mixtures can be formulated for fresh cows, early lactation cows, mid-lactation as well as late-lactation, or close-up dry cows. Cows can be placed in groups created, which are based on actual or fat-corrected milk, days in milk, reproductive status, age, nutrient requirements and health (*Baumgard et al., 2017*). Together with the balance between dietary components that allow for good rumen status, feed particle size distribution and physical efficiency of the diet lead to adequate chewing stimulation mechanisms and rumen fermentation intensity (*Zebeli et al., 2011*). The airm of this paper was to evaluate the precision of loading various TMR components into the chosen mixer feed wagon, as well to evaluate the total precision of the TMR. A hypothesis was established that the weight differences between all the TMR components will not be greater than ± 5 %.

MATERIALS AND METHODS

Farms and animals

The study was performed at a dairy farm located in the Slovak Republic. For the privacy of the selected farm, only the basic information were provided. Only the TMR of the group with the highest milk yield was selected. The TMR consisted of following components: core concentrate, corn silage, lantern silage, wet destillery grain, water. The TMR was fed to the dairy cows twice a day. The weight of the TMR was irregular during the study, varing from 3 672 kg to 4 504 kg per feeding. The milk yield of the selected group of dairy cows was over 35 liters.

Data collection

The study lasted in May 2022. The monitored parameters included: total set weight of TMR components (kg), total loaded weight of TMR components (kg) and the difference of total set weight and total loaded weight (%). Data were extracted from the farm's TMR report and then evaluated in selected statistical software. The selected mixer feed wagon was a Trioliet Solomix 2 1200 ZK with 1 wheel axle (Trioliet, Oldenzaal, The Netherlands).

Figure 1 provides an illustration of the selected mixer feed wagon and Table 1 provides the wagon' basic technical specifications.

Fig. 1 Trioliet Solomix 2 1200 ZK (1 wheel axle)

Tab. 1 Basic technical specifications of Trioliet Solomix 2 1200 ZK (1 wheel axle)

Parameter	Specification	Parameter	Specification
Age	6 years	Height when unloading	0.82 m
Volume	6 m^3	Unloading width	0.92 m
Length	6 m	Payload	4 500 kg
Width	2.24 m	Knives/counter-blades	4/2
Height	2.50 m	Tires	2x 400/45 L 17.5
External width on wheels	1.71 m	Tractor	82 HP

The following formula (1) was used for the calculations of the weight differences between the set and the loaded weight of the TMR components

$$w_d = \frac{w_{l_t} - w_{s_t}}{w_{a_t}} .100 \quad (1)$$

where w_d is weight difference (%), w_{l_t} is the total loaded weight (kg), w_{s_t} is the total set weight (kg)

Data analysis
The data from May 2022 were used for the evaluation. Each component was assessed separately and also the total precision of all five components was calculated. An acceptable permissible limit of ± 5 % was chosen.

Statistical analysis
The data from the TMR report were imported in to Microsoft Office Excel (Microsoft, Redmond, the United States of America). For the purposes of plotting the graphs, the Microsoft Office Excel and a statistical software Statistica 12.5 (TIBCO, Palo Alto, the United States of America) were utilized. Resulting data were given as means ± SD (standard deviation).

RESULTS AND DISCUSSION

Figure 2 shows the weight differences of core concentrate during the period of study. The minimum value was -0.50 %, the maximum value was 14.27 %, the average value was 1.50 %. As the figure 2 shows, there were only 2 of 31 (6.45 %) exceedings bigger than the permissible limit ± 5 %.

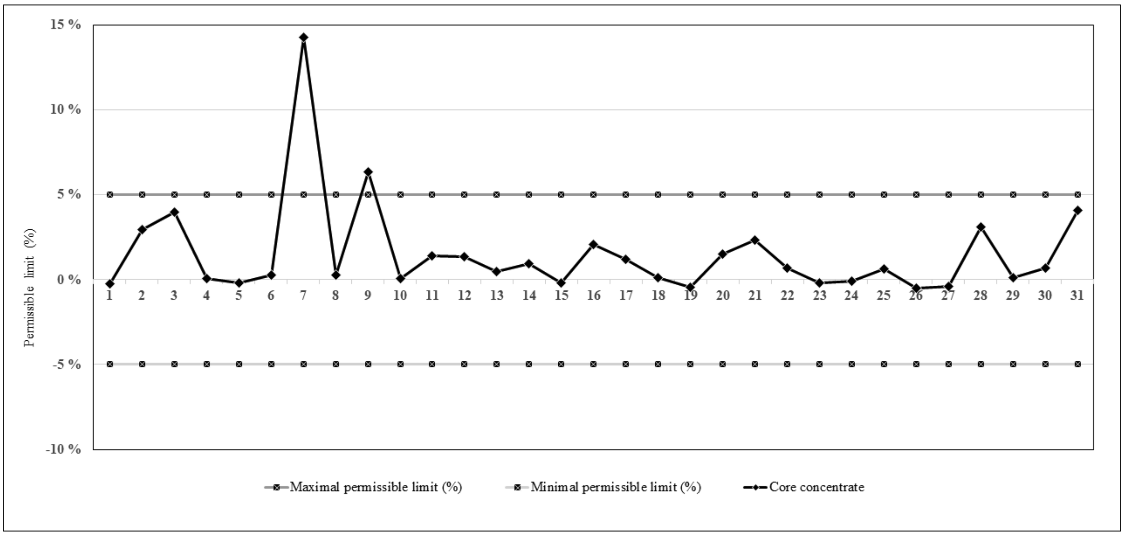

Fig. 2 Core concentrate

Figure 3 shows the weight differences of corn silage during the period of study. The minimum value was -0.24 %, the maximum value was 3.15 %, the average value was 0.60 %. As the figure 3 shows, there were no exceedings bigger than the permissible limit ± 5 %.

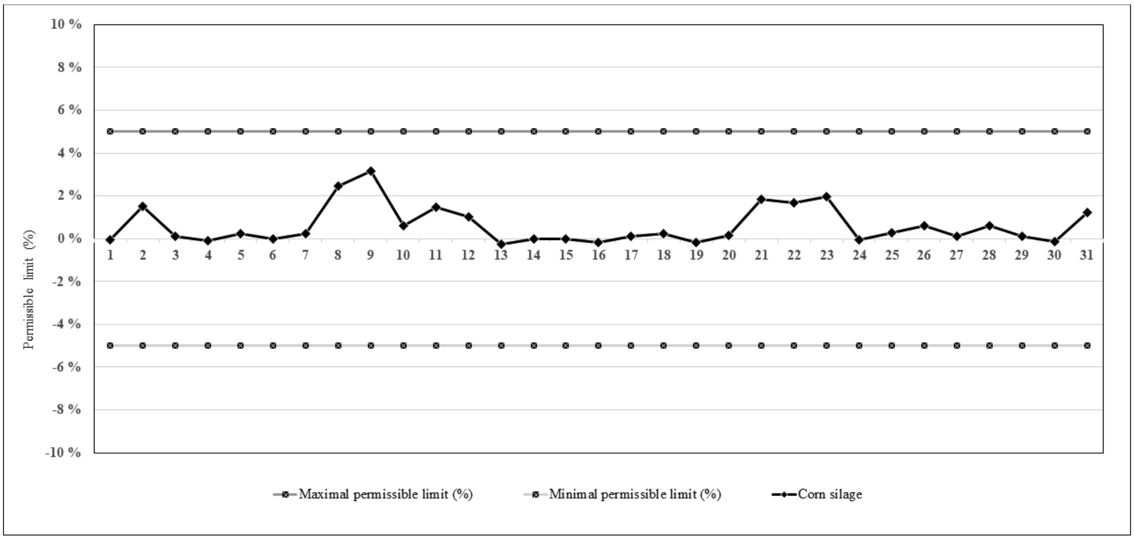

Fig. 3 Corn silage

Figure 4 shows the weight differences of lantern silage during the period of study. The minimum value was -0.91 %, the maximum value was 4.81 %, the average value was 0.81 %. As the figure 4 shows, there were no exceedings bigger than the permissible limit ± 5 %.

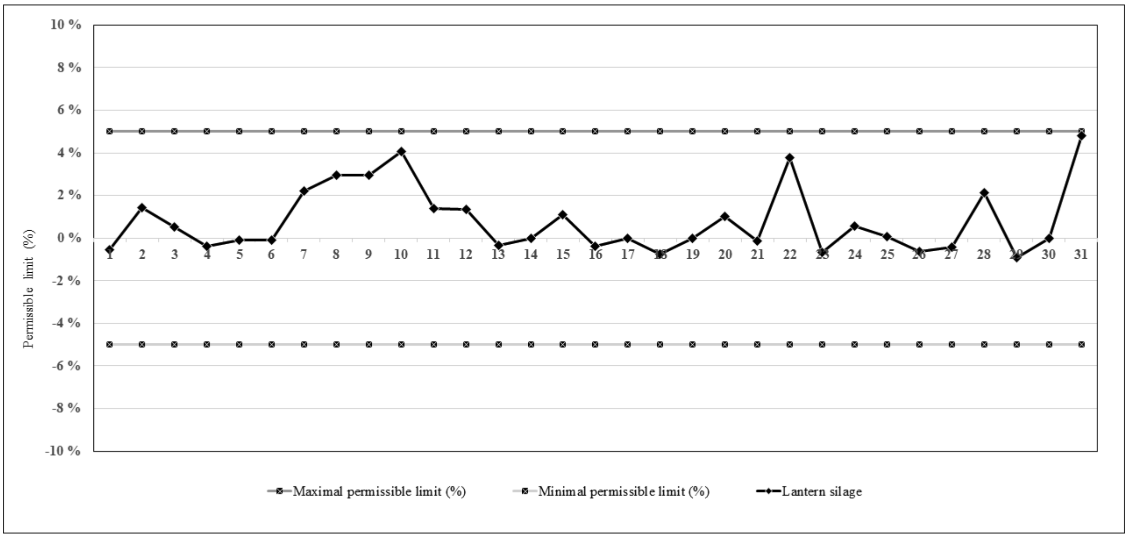

Fig. 4 Lantern silage

Figure 5 shows the weight differences of water during the period of study. The minimum value was -0.18 %, the maximum value was 7.91 %, the average value was 2.55 %. As the figure 5 shows, there were only 3 of 31 (9.68 %) exceedings bigger than the permissible limit ± 5 %.

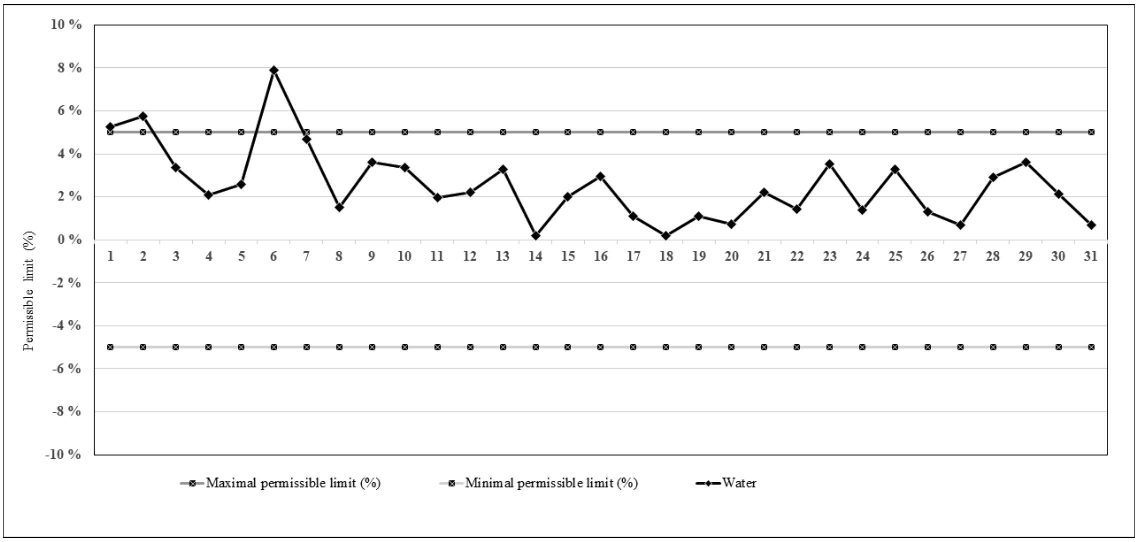

Fig. 5 Water

Figure 6 shows the weight differences of wet destillery grain during the period of study. The minimum value was -49.52 %, the maximum value was 7.54 %, the average value was -2.55 %. As the figure 6 shows, there were only 6 of 31 (19.35 %) exceedings bigger than the permissible limit ± 5 %.

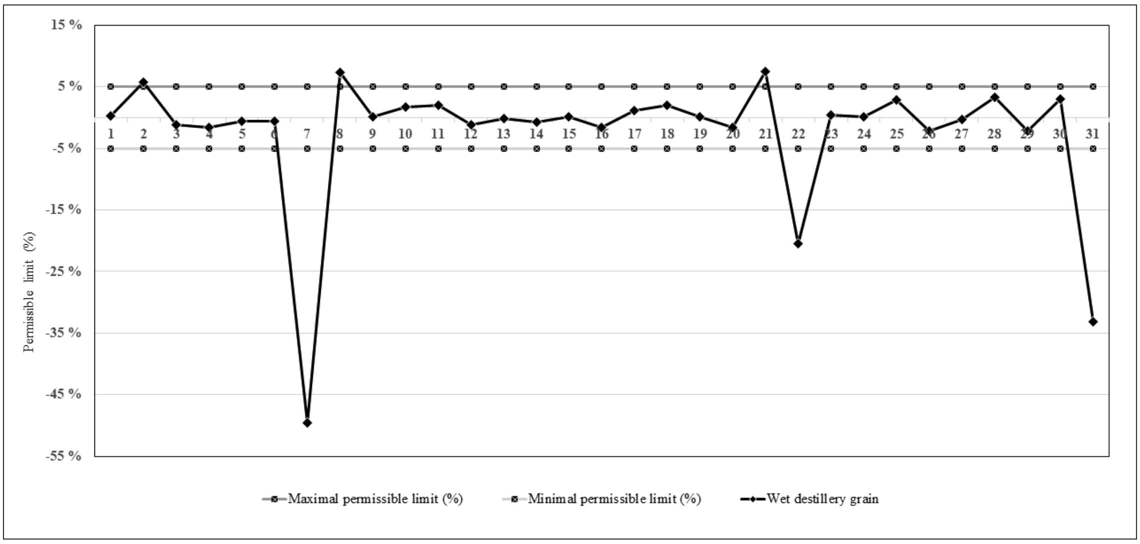

Fig. 6 Wet destillery grain

Figure 7 shows the weight differences of the TMR during the period of study. The minimum value was -0.09 %, the maximum value was 3.68 %, the average value was 0.75 %. As the figure 7 shows, there were no exceedings bigger than the permissible limit ± 5 %. The loading accuracy of the TMR was 99.23 %.

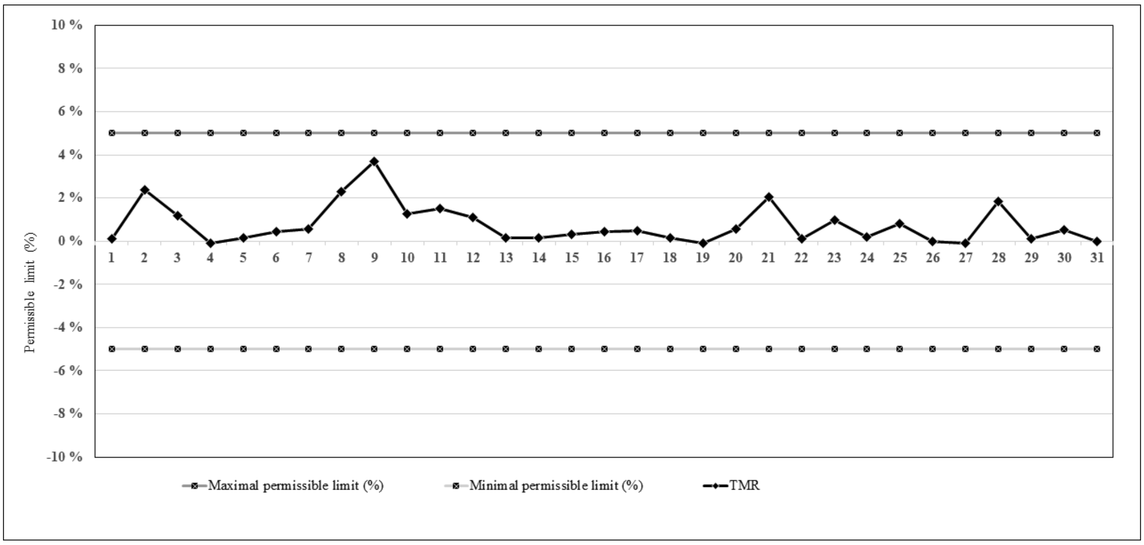

Fig. 7 Total mixed ration

Some authors also achieved similar results, when the quality of the work of feed mixer wagons with both horizontal and vertical augers was compared. In their research they assessed the accuracy of loading the TMR components. They did use three mixer feed wagons with the vertical augers, one mixer feed wagon with a horizontal crushing & mixing system and a self-loader, as well as one self-propelled mixer feed wagon with a vertical crushing & mixing system and a self-loading equipment. Whilst in our TMR we only had 1 TMR with 5 components available, the cited author had 2 TMRs available, the first one with 7 components and the second one with up to 10 components (*Kowalik et al., 2018*).

In another study the authors also dealed with a similar topic, examining the accurate and over-limit and under-limit loadings of each component of two mixer feed wagons with two different TMRs. The first wagon was equipped by a loading cutter integrated in the vehicle, and the second wagon was loaded by an external loader with a loader bucket. The authors used for the study four TMR components: CCM, haylage, silage and straw. It was concluded that the precision did depend not only on the method or used technique, but also on the kind, i.e. properties of loaded components. Loading of TMR components with the loading cutter was considerably more even than with the loader (*Šístková et al., 2015*).

CONCLUSIONS

To put everything into the conclusion, the precision of loading the TMR components into the chosen mixer feed wagon was almost excellent, with the value of 99.23 %. The established hypothesis was confirmed. Three of five TMR components were loaded over the established permissible limit, however the other two TMR components were always loaded under the established limit. The chosen mixer feed wagon does not provide any internal loader, which means it has to be loaded with an external loading machine, guided by the precise information provided by the wagon's own weighing system. Although the mixer feed wagon we used the data from has no loader, and the loading is based on the manual external loading machine, we can say the feeding system works better than we expected. Thanks to the data transferbetween the mixer feed wagon and the local network on the farm we had the data from, it is now easier than ever to use the numbers to create these inputs in a matter of minutes.

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