RECONSTRUCTION OF EXISTING LIVESTOCK FEED PRODUCTION PLANTS BY ADDING A HYDRAULIC ADDER

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RECONSTRUCTION OF EXISTING LIVESTOCK FEED PRODUCTION PLANTS BY ADDING A HYDRAULIC ADDER

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SUMMARY

Recipes determine the quality of livestock feed and the hydraulic adders are one of the elements determining if the given recipe will be carried out. Generally, construction of existing adders does not allow accomplishment of that aim i.e. they do not meet recipe requirements. Consequently, researches which determined deviations in ingredient adding present with existing adders and with the experimental hydraulic adder were conducted. The research was conducted for two years (2005 and 2006) in two livestock feed factories in the Republic of Croatia on samples of feed mixtures for pigs weighing up to 15 and 25 kilos. Relative error was the means for comparison of weighing deviations between the hydraulic adder and the adders powered by means of an electric motor. Research results indicate that none of the two observed livestock feed production plants in 30 repetitions for two kinds of feed mixture showed a feed mixture weighing that would correspond to the specifications in the recipe. Additionally, hydraulic adders showed a greater precision in adding fish meal, extruded soybean and soybean meal when compared with the adders powered by means of an electric motor. However, the adders powered by means of an electric motor showed greater precision in adding corn. Based on the research results it can be concluded that using hydraulic adders instead of the adders powered by means of an electric motor will result in more accuracy in dosing ingredients with fine and middle granularity, whereas this can not be applied to dosing coarse grained ingredients.

Key-words: adders, hydraulic adder, recipes, feed mixtures, livestock feed factory

INTRODUCTION

The process of making a feed mixture does not involve creating a new product. Certain raw materials are cut fine and mixed in certain ratios, thus producing a mixture where each ingredient keeps its own properties (Katić, 1997). Raw materials are added and mixed in certain ratios according to recipes. Recipes determine quality of the final product only provided it was made exactly according to the recipe. In order to achieve that, one of the key devices are adders (Krička, 1988; Kiš and Rak, 1998). Generally, construction of existing adders does not allow accomplishment of the required aim. Research conducted by Krička (1992) and Vojta-Duda (1995) suggests reconstruction of existing livestock feed production plants in the Republic of Croatia. According to the suggested reconstruction, corn is added directly into the mixer, whereas other ingredients are previously weighed and mixed into so called "super". After that the "super" is mixed with corn 1:1 ratio in another mixer with a bigger capacity. "Super" is then transported to a separate chamber placed above a control scale, which was used in the process of filling the continuous mixer. Corn is added to the mixer directly by a double auger device, whose operation is controlled by the scale. This kind of ingredient adding increased the capacity of the plant.

In the world today oil hydraulics is increasingly applied with various kinds of transmission and rotation drives, especially in cases of a greater need of bigger force and rotation momentum (Mc Ellhiney, 1992).

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Advantages of hydraulics in producing and transmitting great powers have recently been augmented by application of proportional hydraulics. Proportional hydraulics allows a very simple regulation of physical factors (force, momentum, speed of movement, and rotation). In addition, application of proportional hydraulics renders the plant management optimization possible, as well as maximum productivity and precision. Proportional hydraulics aided by the latest electronics can very efficiently decrease starting strain, as well as inertial movements that follow the operation shut down, which pose a significant problem in all mechanically powered systems. Finally, application of proportional hydraulics in systems for precision adding, together with control of feed mixture ingredients weighing, increases the plant operation precision (Vojta-Duda, 1997).
Therefore the aim of this paper is to determine differences in precision of adding between an adder powered by an electrical motor and hydraulic adders which are proposed as alternative ways of ingredient adding in existing production plants.

MATERIAL AND METHODS

Researches on differences in adding ingredients into livestock feed mixtures lasted for two years and were conducted in two livestock feed production plants in the Republic of Croatia. Ingredient added by means of adders powered by electrical motors was compared with an experimental hydraulic facility constructed for the purpose of the research. Thirty repetitions were conducted for every ingredient specified by the recipe in every single feed mixture and production plant.
Production plant "A" is a livestock feed production plant with a completely automated production process. Ingredient adding is done by two auger adders powered by a two-speed electrical motor. Weighing is done by an automatic 4000-kilogram hopper scale accuracy class "A". The mixer is a horizontal one with a double spiral. Production process is semi-automated in plant "B". Both auger and circular adders are used in the process of adding. The scale is a hopper and horizontal one with a ribbon mixer with the same capacity. In these plants the command panel operator manually controls the recipe for feed mixture by means of potentiometer.
An experimental facility for adding ingredients have hydraulic adders, so called KVK-adder (Katić-Vojta-Kanajet) constructed for the purpose of the research. There is a 0.8-meter-wide passage between the chambers. The passage reaches the cells manually filled with various ingredients. The scale bin does not have an opening at the bottom, so it is emptied by turning upside-down. A control microprocessor, KVK-adder, with adequate function and memory capacity, is used for generating the electronic control-signal, as well as for accomplishment of other tasks present at the management of batching and mixing process and the whole process of livestock feed production. The function of the KVK-adder is to receive the measure signal for added mass through an electronic measuring cell that guarantees high accuracy to the whole system of livestock feed production. Since many mixers today are equipped with mechanical scales, adders are also adjusted for receiving a signal from a mechanical scale potentiometer.
All results have been statistically processed, and the error was calculated by means of the relative error method. Based on that, a reconstruction of livestock feed production plants was suggested.

RESULTS AND DISCUSSION

Table 1 shows an average weighings of ingredients for feed mixture used for pigs up to 25 kilograms compared with the amounts specified by the recipe. The samples were taken in two livestock feed production plants.
Data in Table 1 show that certain ingredients were added in larger amounts and some in smaller amounts than specified by the recipe. In plant "A" corn was added by means of three adders and all of them added on the average more corn than specified by the recipe, case being the same with fish meal. However the only ingredient added in a smaller amount than specified in the recipe was soybean meal. In plant "A" there was not one weighing of finished feed mixture was correct, and average deviation from the specified amounted to 7.194 kilograms (7.194 kg more than specified). In plant "B" both adders on the average added more corn into the feed mixture than specified, as well as sunflower seed

meal, extruded soybean and fish meal were on the average added in smaller amounts than specified. This resulted in deviation in mass of finished feed mixture amounting to 5.03 kg (5.03 more than specified). Plant “B” as well as plant “A” did not show one correct weighing of finished feed mixture. Other ingredients added into the feed mixture were added exactly the way it was specified, with no deviations.

Table 1. Average weighings of feed mixture ingredients for pigs up to 25 kilograms

PLANT "A"	Corn (kg)	Soy bean meal (kg)	Corn (kg)	Corn (kg)	Fish meal (kg)	Other ingredients (kg)	Total (kg)	Time (min)
SET BY THE RECIPE	441	616	852	1730	180	181	4000	5
X	443,741	614,322	851,419	1735,48	181,225	181	4007,19	5'17"
X_{min}	438	610	850	1734	178	181	4003	5'07"
X_{max}	446	618	856	1736	184	181	4011	5'22"
σ	2,2355	2,1352	1,8757	0,8896	1,8386	0	2,3863	0,0566
c.v.	0,5038	0,3475	0,2203	0,0512	1,0145	0	0,059	1,0705

PLANT "B"	Corn (kg)	Meat and meal (kg)	Extruded soybean (kg)	Fish meal (kg)	Sunflower (kg)	Corn fragments (kg)	Other ingredients (kg)	Total (kg)	Time (min)
SET BY THE RECIPE	1200	150	260	70	120	132	68	2000	5
X	1201,80	147,677	253,483	68	121,871	144,1935	68	2005,03	4'55"
X_{min}	1198	144	250	64	118	142	68	2004	4'46"
X_{max}	1204	152	256	72	126	146	68	2006	5'10"
σ	1,88718	2,42742	1,99784	2	2,061422	1,492634	0	1,016	0,1554
c.v.	0,15702	1,64374	0,78816	2,941	1,691479	1,03516	0	0,050	3,1556

Table 2. Average ingredient weighings for feed mixture for pigs up to 15 kilograms

Plant "A"	Corn (kg)	Soybean meal (kg)	Oats (kg)	Wheat (kg)	Corn (kg)	Fish meal (kg)	Alfalfa (kg)	Calcium carbonat (kg)	Other ingredients. (kg)	Total (kg)	Time
SET BY THE RECIPE	606	872	200	200	1594	160	120	76	172	4000	
X	606,451	871,54	201,87	202,064	1596,32	163,09	121,03	63,221	172	3997,61	5'16"
X_{min}	604	870	200	202	1594	158	118	58	172	3994	5'10"
X_{max}	610	874	204	204	1602	164	124	68	172	4004	5'22"
Σ	2,17315	1,912	1,543	0,35921	3,10254	2,055	2,2432	2,3486	0	3,242	0,052
c.v.	0,35833	0,219	0,764	0,17777	0,19436	1,2600	1,85344	3,7139	0	0,0803	0,987

PLANT "B"	Corn (kg)	Extruded soybean (kg)	Fish meal (kg)	Other ingredients (kg)	Total (kg)	Time (min)
SET BY THE RECIPE	1110	620	90	180	2000	5
X	1111,548	620,9032	89,35484	180	2001,80	4'50"
X_{min}	1110	618	86	180	2000	4'34"
X_{max}	1114	624	92	180	2004	4'58"
Σ	1,120676	1,61977	1,817478	0	1,4926	0,1114
c.v.	0,100821	0,260873	2,034001	0	0,0745	2,3064

Data in Table 2 show that in plant “A”, not one weighing was correct, and average deviation from the specified (difference from the specified total weight) was less than 2.39 kg. Plant “B” added corn and extruded soybean in a larger amount than specified, whereas fishmeal was added in a smaller amount.

Not one weighing of finished feed mixture in plant "B" was correct, and the difference in total specified average and total finished feed mixture average weight was 1.80 kg (more than the specified). In plants "A" and "B" the differences were 5.75 kg in the former and 5.33 in the latter.

Table 3. Average ingredient weighings for feed mixture in the experimental facility "E"

EXPERIMENTAL FACILITY	Corn (g)	Extruded soybean (g)	Fish meal (g)	Soybean meal (g)
SET BY THE RECIPE	800	1200	800	1200
X	795,807	1193,935	801,064	1195,387
x_{min}	791	1187	795	1193
x_{max}	798	1200	807	1198
Σ	1,796652	3,53963	4,00778	1,542237
c.v.	0,225	0,296	0,50	0,129016

Data in Table 3. indicate that corn, extruded soybean and soybean meal were in the experimental facility added in smaller amounts than specified, whereas fishmeal was added in a larger amount than specified. Based on measurement data for ingredient weighing in plants "A" and "B", as well as in the experimental facility "E" by means of the relative error method, errors can be determined in adding certain ingredients into feed mixture for fattening pigs up to 25 kg and 15 kg.
Relative error in adding fish meal into feed mixture for pigs up to 25 kg was the largest in livestock feed production plant "B", amounting to 30.41‰, whereas the smallest was in the experimental facility, being 4.556‰. Relative error in adding soybean meal was the biggest in plant "A" – 33.54‰, and it was the smallest in the experimental facility – 3.84‰. Relative error in adding extruded soybean was the biggest in plant "B" – 25.06‰, and the smallest in the experimental facility, being 5.053‰.
Relative error for adding fishmeal into the feed mixture for pigs up to 15 kg was the biggest in plant "A", amounting to 21.744‰. It was the smallest in the experimental facility – 4.556‰. Relative error in adding soybean meal was also the biggest in plant "A", amounting to 21,56‰ and the smallest in the experimental facility – 3.844‰. The biggest relative error for extruded soybean was 20.80‰ in plant "B" and the smallest in the experimental facility, being 5.053‰.

CONCLUSION

The following can be concluded based on the results of the research:

1. There is a difference among the observed production plants in number of feed mixture ingredients being added into feed mixtures for pigs up to 15 kilograms and into feed mixture for pigs up to 25 kilograms alike.
2. Also, there are differences among the observed plants in accuracy in adding certain ingredients into feed mixtures and not one weighings corresponded to the ones specified in the recipe.
3. Using the hydraulic adder instead of an adder with an electrical motor will result in a higher precision in adding fine grain or coarse grained ingredients. In adding coarse-grained ingredients, the existing adders, i.e. adders powered by electric motors, showed a higher accuracy than hydraulic adders, which means that they do not have to be replaced by hydraulic adders in the existing plants.

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