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Feed manufacturers' perceptions on the utilisation of heritage grains and exogenous enzymes in ration formulation in Zimbabwe

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ABSTRACT

The aim of this study was to assess the level of utilisation of small grains, perceptions towards the use of these grains in feed formulation as well as the benefits and challenges associated with their use in feed formulation. The levels of knowledge of antinutritional factors (ANFs) in small grains, ways of combating the identified ANFs and the use of feed enzymes in ameliorating the effects of these ANFs was also assessed. A survey was conducted in this study. Out of the sixteen feed companies listed by the Stockfeed Manufacturers Association of Zimbabwe, a total of ten (10) were interviewed. The collected data were analysed using IBM SPSS ver. 25 of 2017. The data were analysed for descriptive statistics and Chi-square tests were performed to test for possible associations between variables. Of the interviewed feed companies, only 25% reported that they use small grains in feed formulation. The respondents identified high cost, long distance in combination with high transportation cost, seasonal shortages and stockouts as well as quality inconsistencies from one batch or supplier to the other as the main challenges faced when sourcing small grains. All (100%) the respondents showed knowledge of the use of exogenous feed enzymes in livestock feeds. It can be concluded that small grains are lowly utilized by the feed companies in the country while use of feed enzymes is a common practice amongst them.

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INTRODUCTION

The least cost formula that allows provision of adequate energy and meets the different nutrient requirements of the livestock species in question is used by the feed manufacturers this ensures reduction of costs while maximizing profits (Nyhodo *et al*., 2014). Poultry feeds are mainly formulated using maize, soybean meal, amino acids and mineral premixes. Maize is the key cereal used in poultry diets and it contributes approximately 65% of the metabolizable energy, 30% crude protein (Pands *et al*., 2013)

and 50-70% of the total diet (Ojewola and Olugbemi, 2011). However, it has a high risk of failure under drought conditions leading to high maize cost and drastic shortage to meet the demand for human consumption and livestock feed production (Wakibia, 2015). Small grains such as sorghum and millets are other cereals that can be used in broiler feed formulation.

Small grains are known for their remarkable ability to thrive and flourish in harsh climatic conditions (Karim *et al*., 2022). Additionally, millets are more resistant to pests and diseases, drought-tolerant (thrive under low rainfall as low as 200 to 250 mm) thus can yield more (Saxena *et al*., 2018). They also have a short growing season which allows them to complete their productive cycle in a short time (Devi *et al*., 2011). In Zimbabwe, average small grains production for the years 2017- 2021 stood at 130 000 tonnes and this increased to 240 000 metric tonnes during the 2021-22 cropping season (FEWS NET, 2022). Also referred to as heritage grains, the small grains have a nutritional composition which is comparable to that of maize hence they are the most competitive alternatives of maize (Saleh *et al*., 2013). The crude protein content of the small grains ranges from 8.99% (Jocylene *et al*., 2020) to 13. 40% (Alvarenga *et al*., 2018). Average ash, fat and carbohydrate content of sorghum are 1.22, 2.23 and 73.13% respectively (Pontieri *et al*., 2022). Millets contain between 1.8 to 5.0% fat, 2.2-2.7% ash and 65.0 to 83.3% carbohydrate (Amadou *et al*., 2013). Despite all these advantages, their utilization in the livestock feed industry remains low due to several unknown factors.

The presence of antinutritional factors (ANFs) such as tannins and phytate affects utilization of small grains by livestock. The ANFs complex with phosphorus (and several other minerals) and proteins including digestive enzymes in the gastrointestinal tract thus reducing enzyme activity and nutrients digestibility (Selle *et al*., 2012). Ways of dealing with these ANFs need to explored in order to ensure effective utilization of small grains by the livestock. Exogenous enzymes can be added to feed enzymes to reduce the effects of these ANFs.

The aim of this study was to investigate the reasons behind poor utilization of small grains in feed formulation from the feed manufacturers' perspective. The study also aimed at assessing the level of knowledge concerning the use of feed enzymes in ameliorating the effects of sorghum and millets antinutritional factors.

MATERIALS AND METHODS

Study site

The study was conducted in Zimbabwe targeting all the feed manufacturing companies and livestock producing companies that manufacture feeds for own use or for resale. All the companies were registered with the Stock Feeds Manufacturers of Zimbabwe (SMZ).

Tools and sampling procedure

The interviews were conducted using a standard semi structured questionnaire which was administered through face-to-face interviews. The questionnaire was pre-tested before the actual survey to establish the relevance of the questions, sensitivity as well as improve the reliability of data collected. The questionnaire collected information on characteristics of the company and respondents, general information on feed manufacturing, level of heritage grains utilization in feed formulation, knowledge of antinutritional factors as well the use of feed enzymes in ameliorating the effects of these ANFs. There are sixteen feed companies registered by the Stockfeed Manufacturers of Zimbabwe and these were eligible to participate in the survey.

Data analysis

The data were analyzed using IBM SPSS Statistics ver. 25 of 2017. The analysis focused on generation of descriptive statistics related to heritage grains utilization, reasons for low or non-utilization and level of acceptance of the grains. The data on knowledge of the benefits, presence of antinutritional factors (ANFs), ways of reducing concentrations of these ANFs and the use of exogenous feed enzymes in mitigating the effects of ANFs were also subjected to similar analyses. Chi-square test was used to test for possible associations between variables. All tests were conducted at $p< 0.05$ level of significance.

RESULTS

Characteristics of respondents

Majority (75%) of the respondents were male. The mean age group of the respondents was 35 (SD= 0. 744). The mean number of years business has been operating is 48 (SD =34.232). All (100%) the respondents attained tertiary education.

General feed manufacturing aspects

Of the interviewed companies, only 37.5% indicated that they make feed for own use while the rest (62.5%) have retail outlets. Straight and concentrate broiler feeds were the most common (62.5%) feed type manufactured. Beef survival, cattle pen fattening, pig creep, weaner, lactation, grower, finisher meals were the other feeds manufactured. The most common type of feed as reported in this study was poultry feed (75%) with the other feeds produced being cattle (62.5%), pig (37.5%), small ruminants (37.5%), fish (12.5%), rabbit (25%), dog (12.5%), horse (12.5%) and crocodile (12.5%) feeds. Majority (75%) of the poultry feed producers produce broiler feeds. Quality (87.5%) was the most important factor considered when choosing feed ingredients. Other factors considered are as shown (Table 1).

Table 1. Factors that influence the choice of feed ingredients

Factor considered	Rank (%)				
	1	2	3	4	5
Quality	87.5	12.5	0.0	0.0	0.0
Price	12.5	50.0	25.0	12.5	0.0
Easy availability	0.0	37.5	50.0	12.5	0.0
Preference	12.5	0.0	12.5	50.0	25.0
Supplier's reputation	0.0	0.0	12.5	25.0	62.5

Small grains as livestock feed ingredients

All the respondents (100%) indicated knowledge of small grains and they all listed white sorghum of (WS), red sorghum (RS), pearl millet (PM) and finger millet (FM) as small grains. Respondents stated different uses of the small grains as shown (Table 2). Only 25% of the respondents stated that they use small grains in feed formulation.

Table 2: The uses of small grains as reported by the feed manufacturers

Role of small grains	Frequency (%)
Mealie meal	100
Traditional beer	62.5
Ceremonies (Introduction of the wife to new family after the wedding and ritual-myth)	25.0
Feed formulation	25.0

White sorghum was reported to be ideal for poultry (75%), cattle (25%), pig (12.5%) and horse (12.5%) feed formulation. The respondents stated that pearl millet is suitable for poultry (37.5%) and cattle feed formulation (12.5%). Red sorghum (25%) and finger millet (37.5%) were indicated to be useful in the formulation of indigenous chicken feed. The majority of the respondents (50%) stated that small grains are expensive and highlighted the Grain Marketing Board is the sole buyer thus monopoly is leading to the high price.

Majority of the respondents (62.5%) indicated that they have future plans of using small grains in feed formulation. Some (25%) of the companies are already using the small grains while 25% are conducting research/feeding trials to evaluate use of these grains as feed ingredients. A small proportion (12.5%) indicated that they are already producing their own small grains meant for livestock feeds. Chi-square test results indicated that there was no association between range of feeds produced and plans to use small grains in the future (X^2=40.1, DF= 4, P> 0.01).

Factors limiting the use of small grains in feed formulation

The most important factor limiting the use of small grains in feed formulation was lack of knowledge and awareness (62.5%) with absence of sophisticated machinery for processing being the least limiting factor (87.5%). Other factors that limit the use of small grains in feed formulation are as shown (Table 3).

Table 3: Ranking of the factors that limit the use of small grains in feed formulation

Factor	Rank (%)				
	1	**2**	**3**	**4**	**5**
Unavailability	25.0	25.0	0.0	25.0	25.0
Expensive	0.0	37.5	37.5	25.0	0.0
Lack of knowledge	62.5	25.0	0.0	0.0	12.5
Unfamiliar	12.5	25.0	37.5	25.0	0.0
Sophisticated machinery is needed	0.0	12.5	0.0	0.0	87.5

Apart from the limiting factors listed above, respondents were asked whether small grains ANFs have any effect on the utilization of these grains in feed formulation. Most of the respondents (87.5%) showed knowledge of small grains antinutritional factors and indicated that these affect use of these grains in formulations. The ANFs were reported to negatively affect voluntary feed intake (87.5%), feed use efficiency (62.5%), nutrients digestibility (100%), average daily gain (100%), amino acid availability (100%) and cold dressed mass (12.5%). Chi-square test results indicated that there was no association between age of respondent and knowledge on small grains ANFs (X^2=19, DF=2, P >0.01). The respondents showed knowledge of the different ways of minimising small grains antinutritional factors in the diets. These include decortification (12.5%), use of new cultivars (12.5%) and reducing the inclusion level of these grains in livestock diets (12.5%) as well as use of feed enzymes (62.5%). Most (62.5%) respondents recommended genetic engineering as a strategy to improve the nutritional quality of small grains.

Ways of promoting use of small grains in feed formulation

The respondents highlighted major ways of promoting use of small grains in feed formulation. These include improving availability of SGs of good quality and price (50.0%), educating farmers making them aware that they stand a better chance during drought if they grow SGs in place of maize (37.5%), pricing of SGs need to be market guided not government gazetted (12.5%) and that information on the nutritional composition of SGs and their advantages need to be made available (12.5%). Majority (62.5%) of the respondents indicated that small grains have no advantages over other cereals like maize. Of the advantages of small grains cited, ability to thrive under drought conditions was the most common (37.5%).

Use of exogenous enzymes in ameliorating small ANFs

The majority (62.5%) of the respondents indicated that enzymes can be used in ameliorating the effects of small grains ANFs. Carbohydrases and phytase were the common enzymes cited. The reasons for low utilization of exogenous enzymes are shown in Table 4. Generally, most respondents (87.5%) recommended future use of exogenous enzymes as livestock feed additives. Chi-square test results showed that there was no significant association between range of livestock feed produced and use of exogenous enzymes in feed formulations (X^2=36.2, DF= 6, P>0.01).

Table 4: Factors that limit use of exogenous enzymes in livestock formulations

Factor	Rank (%)		
	1	**2**	**3**
Locally unavailable	62.5	37.5	0.0
Expensive	25.0	75.0	0.0
Perception of genetic modification	0.0	0.0	100.0

Discussion

The observation that poultry feed products dominate the feed industry is similar to earlier findings (Githinji *et al*., 2009; Geerts, 2014). Poultry feed sustained the first position because of the perceived healthiness, flexibility in cooking use and religious preferences as well as relatively low cost of chicken meat (Alltech, 2014).

The challenges faced by the feed manufacturers in the current study agrees to those reported in Tanzania (Geerts, 2014). In Tanzania, the respondents cited lack of credit facilities, lack of government support through extension services, training of feed formulation, high cost of raw materials, poor quality raw materials, high cost of laboratory services and lack of analytical as the main challenges faced. Heritage grains are not readily available on the market because they are produced in the marginal areas located far from the capital cities. Also, there are inefficient marketing systems for these grains thus giving maize a competition advantage over sorghum and millets. This agrees with previous findings (Deribe and Kassa, 2020) who observed that surplus sorghum producing farmers are located far from Addis ababa, the capital city of Ethiopia.

The results on the uses of small grains are similar to earlier findings. These include commercial production of malt meant for the making of traditional opaque beer for special festivals, weddings, and occasions (Deribe and Kassa, 2020). Sorghum is also a good basis for gluten-free breads and other baked products like cakes and cookies (biscuits) and in snacks and pasta (Deribe and Kassa, 2020). The result that sorghum and millets are suitable for use in poultry feed formulation agrees with earlier findings (Batonon-Alavo *et al*., 2015). They observed that millet can be partially or completely

substituted in broiler diets without causing detrimental effects on performance. The use of sorghum in pig diets was also reported earlier (Thomas *et al*., 2020; Puntigam *et al*., 2021). The authors highlighted that sorghum can successfully be used in nursery pig diets with special consideration given to differences in amino acid digestibility. Additionally, the finger and pearl millet are ideal for small ruminants ration formulation in place of conventional grains (Hassan *et al*., 2021). In contrast, Masenya *et al*. (2021) highlighted that pearl millet can be used without causing reduction in performance while sorghum reduced performance of quail birds.

The utilisation of heritage grains is influenced by several factors as observed in the current study. The level of awareness and the innovation tendency of the manufacturing companies significantly influences diversification and attempts of utilization of these grains. The awareness on the nutritional attributes of a product play an important role on purchases of the item (Themba, 2013).

The external environment also influences purchasing choices and utilisation of products. The external environment includes culture, social class, reference groups and families, globalisation, competition, economic as well as political and technological factors (Kotler and Armstrong, 2013). The purchasing behaviour of consumers is also influenced by the marketing of products/items (Naseem *et al*., 2021). The current finding that price influences purchasing power agrees with earlier observations (Jabarzare and Rasti-Barzoki, 2020; Huo *et al*., 2021) hence any product available at an affordable price can be purchased. The finding that availability influences the purchasing behaviour agrees with previous findings (Weissmann and Hock, 2021) because product availability at the physical retailers is a major factor that influences the likelihood of its purchase (Chuang *et al*., 2016).

The informants in the current study identified heritage grains antinutritional factors and ways of reducing the effects of these antinutrients. Fermentation, germination, enzymatic hydrolysis, heating, cooking, dercotication/dehulling, chemical treatments and soaking were also cited in previous studies as procedures that reduce the effects of the small grains anti-nutritional factors (Diouf *et al*., 2019). Exogenous enzyme technology is a common practice in the livestock feed industry on the basis that the enzymes will be resistant to proteolytic enzymes and active in the gastrointestinal tract (GIT) (Dersjant *et al*., 2014). The observation that high cost of feed enzymes reduces their utilisation in livestock feeds agrees with previous results (Anyaegbu *et al*., 2021). They observed that supplementing sorghum-based diets with phytase enzyme resulted in high feed costs compared to diets without enzyme supplement. In contrast, other findings suggested that feed enzymes are cheaper and safer than chemical methods (Zarei *et al*., 2022)

The current results on ways to promote heritage grains utilisation agrees with previous results. Rasanjali *et al*. (2021) found that farmer training that on regular monitoring of varieties used, fertilizer application, weeding and harvesting resulted in high yields

and adoption of heritage grains production be the farmers. In addition, poultry feeding trials which involves poultry nutritionists conducting feeding trials at the insistence of the feed industry promoted utilisation of heritage grains in India (Parthasarathy Rao *et al*., 2005). The establishment of market linkages to link small-scale small grains producers with poultry feed manufacturers was found to promote their utilisation in feed formulation (Parthasarathy Rao *et al*., 2005). The importance of linking small scale farmers to market was thoroughly evaluated (Ferris *et al*., 2013) and this was found to be an important factor of product utilisation.

Small grains can be used in on farm ration formulation programmes and this could result in better logistics and low feed transportation cost (Silveira *et al*., 2017).

CONCLUSION AND RECOMMENDATIONS

Heritage grains are lowly utilized in the manufacture of livestock feeds and this is attributed mainly to lack of knowledge/awareness on their nutritional attributes, low availability and high cost. Heritage grains contain antinutritional factors and the effects of these ANFs can be minimized through decortication/dehulling, germination and use of enzyme treatments. The use of exogenous enzymes as livestock feed additives is common practice among the feed manufacturing companies in the country but tends to be limited by their high cost.

The authors recommend nutritional and antinutritional factors profiling of the heritage grains in future studies. Feeding trials that explore the efficacy of exogenous enzymes in reducing the effects of heritage grains antinutritional factors in different livestock species are of paramount importance.

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Researchers' contribution

RP Magaya contributed to the project idea, design the methodology, conducted the survey and wrote the first draft of the article. T Mutibvu, ET Nyahangare and S Ncube supervised the study and wrote the manuscript

Conflict of interest

The authors declare that there are no competing interests.

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