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A Study on Quinoa (amaranth) as a Source of Iron in Piglets

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ABSTRACT

The objective of this study was to evaluate the possibility of quinoa (Amaranth) as an iron supplementation in piglets. Three amaranthus species were used in the study, including Amaranthus spininosus, Palmeri amaranthus, and Amaranthus hybridus. The content of iron was determined by atomic absorption spectrophotometry (AAS). F test was used to compare the differences between different treatments. The results showed that there were significant differences in iron content among the three plants ($P < 0.05$), and the hybrid plant had the highest iron content. Studies have shown that quinoa (amaranth) contains iron and can be used as a source of iron in piglets. The current study suggests that farmers consider using hybrid plants as an alternative source of iron supplements for piglets, but the relationship between iron availability in soil types and amaranth species in a particular area needs to be tracked.

KEYWORDS

Amaranthus; Alternative; Iron; Levels; Piglets; Species.

1. Introduction

Anaemia is the most prevalent nutritional deficiency in the world. Attempts to improve iron status have been thwarted by deficiency of adverse interaction with other micronutrients. Confinement-reared pigs develop iron deficiency anaemia (hypochromic, microcytic anaemia) early in life. Anaemia occurs because piglets are born with unusually small iron stores since milk contains low levels of iron, and pigs have a very rapid growth rate. Anaemia interferes with growth, and affected pigs are listless and more susceptible to infectious diseases than are normal pigs (Victor and Mary, 2012). Piglets are born with a small supply of iron than most animals, yet they require a great deal of this mineral due to their rapid growth rate. Piglets born outdoors or in the wild get iron by rooting in the soil, but the only source of nutrients available to piglets born indoors is sow's milk, which contains no iron. Swine producers raise pigs in confinement buildings which necessitates injection of piglets with supplemental iron (Lowe et al., 2017).

Piglet anaemia also called Iron deficiency anaemia is a hypochromic-microcytic anaemia generally associated with young, rapidly growing piglets deprived of iron in their diet or from their environment. It has been a potential problem since swine producer's first farrowed litters in confinement, denying the nursing pig access to iron in the soil. The pig is born with a normal level of haemoglobin in the blood of 12 to 13 g/100ml and this rapidly drops down to 6 to 7 g/100ml by 10 to 14 days of age A shortage of iron results in lowered levels of haemoglobin in the red blood cells, (anaemia), a lowered capacity for the carriage of oxygen around the body and an increased susceptibility to disease. Iron is a vital component in forming haemoglobin, a protein comprising about one-third the weight of the red blood cell. Haemoglobin within the red blood cell has the unique function of carrying oxygen from the lungs to the tissues of the body in support of cellular metabolism and transporting carbon dioxide resulting from cellular metabolism back to the lungs. When there is a deficiency of iron, the baby pig cannot synthesize an adequate amount of haemoglobin. Thus, baby pig anaemia is a condition of the blood in which the oxygen-carrying capacity is greatly reduced, and this condition is generally due to iron deficiency. The piglet is born with limited supplies of iron and if it has been born in the wild would depend on supplementation to its diet from iron bearing soils. Indoors, the pig has no access to iron other than the sows' milk (which is deficient) until it starts to eat creep feed (Nath et al., 2015).

Several management approaches have been postulated and they include: (1) A shovelful of clean earth given daily and sprinkled with Iron-sulphate, (2) Ashes sprinkled with a copper-iron solution (3) Various oral mixtures can be used and are placed on the back of the tongue; these are best given within 36 hours of birth to be effective, (4) Iron can also be provided in piglets' drinking water, with a dispenser placed in the creep area, (5) Iron-sulphate paste can be painted onto the sows teats every 2 to 3 days, (6) Use of iron licks or blocks, (7) administration of 200 mg (i/m) of iron dextran as a single dose is sufficient and (8) The easiest method is to give the piglet an injection of 150 to 200 mg of iron dextran in either a 1 or 2 ml dose. Iron is best given from 3 to 5 days of age and not at birth, because a 2 ml dose at birth causes consideration trauma to the muscles (Kay et al., 1980). Iron can also be given orally but this method is time consuming and the pig must be treated on 2 or 3 occasions at 7, 10 and 15 days age. Oral pastes available ad lib has been used but the uptake within any litter is variable and a few piglets remain anaemic (Victor and Mary, 2012).

Wild plants play a very vital role in the health of humans as well as animals. Like many other vegetables, it is a good source of vitamins and roughage including proteins. One of these plants is the Amaranthus species which is a highly popular group of vegetables that belong to different spices (Costea and Sanders, 2001). Amaranthus has minerals of importance which are calcium and iron. For this, it can be used in feedlot for animals (Dada et al., 2013). Amaranthus is highly nutritious, both the amaranth grain and leaves are utilized for human food as well as for animal feed (Tucker, 1986). Amaranthus is the genus for the pigweed family. It is collectively known as amaranth or pigweed and it is a cosmopolitan genus of herbs (Dada et al., 2013).

2. General Description and Uses of Pig Weed (Amaranthus)

Amaranthus species are a highly popular group of a vegetables that belong to different species (Costea and Sanders, 2001). A. hybridus, commonly called smooth amaranth, smooth pigweed, red Amaranth, green Amaranth or slim Amaranth, is a species of annual flowering plant. It is a weedy species found now over much of North America and introduced into Europe and Eurasia. A. hybridus was originally a pioneer plant in eastern North America. It has been reported to have been found in every state except Wyoming, Utah, and Alaska. It is also found in many provinces of Canada, and in parts of Mexico, the West Indies, Central America, and South America. It has been naturalized in many places of warmer climates. It grows in many different places, including disturbed habitats (Davis et al., 2005).

The A. palmeri plants are leafy and somewhat tall. They typically grow around 3 to 6 feet tall but can reach up to 15 feet in native growing conditions. The leaves are broad lance shaped, and anywhere from 2 to 8 inches long. They are green with prominent white veins underneath and have long petioles. The pigweed's green flowers are very small and grow in dense, cone-shaped clusters at the top of the plant. Male and female flowers grow on different plants. When mature and dry, the flower spikes are scratchy and tough. They produce tiny, dark, and shiny seeds (Scott, 2010).

Amaranth is a poorly exploited plant in different areas: food, health and economic use despite its high potential (Kim et al., 2012). While originating from tropical America, Amaranth is now very widely distributed throughout the tropics. Amaranth is a herbaceous annual plant belonging to the family Amaranthaceae with green or red leaves and branched flower stalks (heads) bearing small seeds, variable in colour. However, only a limited number are of the cultivated types, while most are considered weedy species and hence rarely preserved. Many Amaranth species are collected from the wild for subsistence, while only few are cultivated or occur as protected weeds in backyards and home gardens (Stallknecht and SchulzSchaeffer, 1993; Keller, 2005).

Amaranth can be used as a high-protein grain or as a leafy vegetable. The seeds are eaten as a cereal grain. They are ground into flour, popped like popcorn or cooked into porridge. The seed can be germinated into nutritious sprouts (GFU for underutilized Species). The leaves are cooked alone or combined with other local vegetables such as spider plant and carbohydrates (Keller, 2005). There is no distinct separation between the vegetable and grain type since the leaves of young grain type plants can be eaten as greens (Stallknecht and Schulz-Schaeffer, 1993).

3. Climatic Conditions and Water Management

Amaranth grows form sea level to 2400 m altitude. The different species may suit different altitudes. Amaranth is grown during both wet and dry seasons, though irrigation is normally required for dry season crops since the rate of transpiration by the leaves is fairly high. Frequent applications of water are required, related to the state of growth of the crop and the moisture-retaining capacity of soil. It can however tolerate periods of drought after the plant has become established. It is adapted from low to medium humidity. Normally the hotter it is the better it grows and it generally thrives within a temperature range of 22 to 30oC. A minimum temperature of 15 to 17oC is needed for seed germination (Sharma et al., 2012).

Baral et al. (2010) reported that Amaranthus spinosus is used to treat intestinal worm infection. They further observed that the extract from this species of Amaranthus has anti-inflammatory activities and signgificant inhibition of Carrageem induced paw oedema. Amaranthus has antiinflammatory properties, immunemodulatory activity, antiandrogenic activity and anti-helmentic properties (O' Brien and Price, 2013).

4. Problem Statement

Rural communities do not have access to conventional iron supplement feed. Conventional iron supplement is expensive for most small scale livestock farmers and there is need to identify a cheap locally available alternative source of iron. The efficacy of cheap locally available types of forage that can be used as substitute to conversional iron supplement such as pigweed has not been evaluated. Hence, the objective of the research was to compare the iron content levels among the three (3) varieties (A. spinosus, A. palmeri and A. hybridus) of pigweeds.

5. Methodology

Research site

The research was conducted in Choma district of Southern Province. Choma is a town about 285 km from Lusaka. Choma is situated at 16.82o South latitude, 26.98o East longitude and lies at an altitude of 1325 m above sea level. Choma is a small town in Zambia, having about 46,746 inhabitants (Central Statistics Records CSO, 2010). It has the typical climate of southern Zambia with temperature between 14oC and 28oC and sunshine ranging from nine (9) and twelve (12) hours per day. The highest temperatures are recorded between the beginnings of October and the end of December. The lowest temperatures are usually recorded in June and July (Choma Metrological Station, 2015). Soil type ranges from sandy loam to loam.

Treatments and replications

The experiment involved three (3) treatments each replicated nine (9) times, giving a total of twenty seven (27) experimental samples.

Sampling technique

Nine (9) samples of each of A. spinosus, A. palmeri and A. hybridus were randomly selected from the field in the same area experiencing similar climatic and soil conditions. The process involved a transect walk and picking a plant of each species after five (5) meters. Samples were from plants of similar middle age of at least 0.5 meters height. The plants collected had fresh leaves (vigour leaves) since they are more biologically active than old dry leaves. The three (3) pigweed types were picked on the basis that they are the most common species in Choma area and the Southern Province of Zambia.

Proximate analysis

Three (3) samples of whole plant were subjected to proximate analysis for iron content at Mount Makulu Research Station using the Atomic Absorption Spectrophotometer (AAS) by the method of Van Soest and Moore (1990). The three (3) common types of Amaranthus (A. spinosus, A. palmeri and A. hybridus) totalling nine (9) plants for each species were packed in three (3) bundles and labelled "A, B and C" each containing three (3) samples of each species. Additionally, there were 9 tests.

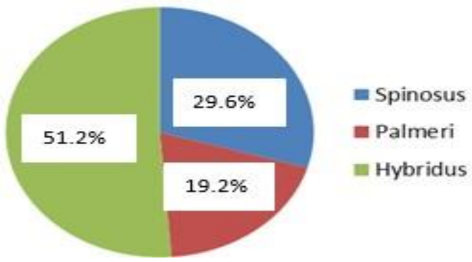

Figure 1. Comparisons of Iron content (%) for species

Table 1. Analysis of variance for iron content

Source of variation	df	SS	Ms	Fcal	Ftab
Total	8	119656.58			
Treatment	2	115222.69	57611.35	77.96	5.14
Error	6	4433.87	738.98		

Table 2. Mean separation for iron content

A. species	Spinosus	Palmeri	Hybridus	LSD
Spinosus	-	87.678*	183.87*	
Palmeri	87.6788*	-	271.54*	51.2
Hybridus	183.89*	271.54*	-	

6. Results and Discussion

Results of the study indicated that Palmeri species had the lowest (165.16 ppm) while Hybridus species had the highest (435.16 ppm) iron content (Table 1 and Figure 1). Statistical analysis revealed that the iron content differed significantly ($p<0.05$) among the three (3) species used in the study (Table 2). It was observed from mean separation (Table 3) that all three (3) species differed significantly ($p<0.05$) in iron content. Of the total Iron content available from the three (3) specimen samples the proportions for A. hybridus, A. spinosus and A. palmeri species were 51.2%, 29.6%, and 19.2% respectively (Figure 2). Results of this study are at variance with those of Mohil and Jain (2012) who recorded 13.70, 13.10 and 11.0 (mg/100g dw) levels of iron content in A. hybridus, A. palmeri and A. spinosus samples collected from various parts of India. However, work by these researchers showed that the Hybridus species still showed the highest iron content among the three (3) species.

The problem of iron deficiency in animals can be overcome through the use of iron supplementary powder Nutraceuticals product from developed Moringa oleifera and Amaranthus polygonoides (Manikandaselvi and Nithya, 2011). Iron content in plants is a factor of several conditions. Firstly, its availability in the soil influences its availability in plants. Depending on the parent rock soils differ in their iron content and this is directly related to its availability to plants growing in the environment. The soil iron content on which the amaranthus species were obtained had iron content levels of 14.60 ppm (Table 4). Secondly, the ability of a plant to absorb and store iron is highly related to the genetic composition of the plant. Plant varieties and cultivars differ genetically in their ability to absorb and store mineral salts including iron.

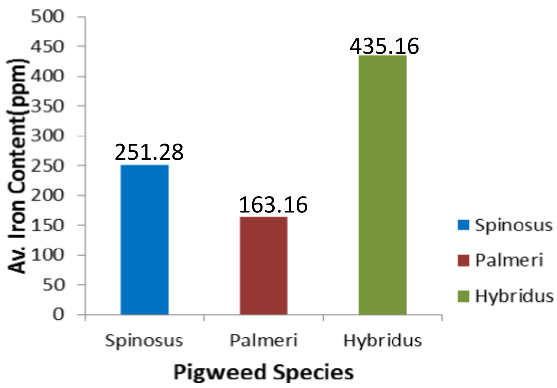

Figure 2. Comparisons of Iron content (%) for species

Sharma et al. (2012) reported an average of 60% iron content in the three (3) amaranthus species. Elemental analyses in mg/100 grams on dry weight basis by Kachiguma et al. (2015) indicated that the grain iron content ranged from 3.61 to 22.51, while the mean mineral leaf analyses ranged from 14.84 to 31.17. Observations of these researchers agreed with those of the current study and those of Mohil and Jain (2012) by indicating that the hybridus species ranked highest in iron content. These researchers further reported differences in iron content among and within species from different locations.

During an investigation for alternative sources of iron, Kone et al. (2012) reported eleven (11) medicinal plants showing presence of iron in various quantities. The most promising were Tectona grandis, Amaranthus spinosus and Stylosanthes erecta which contained the highest iron contents viz; 266.6, 236.6 and 206.6 mg/100 g respectively.

Differences in iron content in samples of Amaranthus species from different regions indicate influence of environmental conditions under which the species are grown. Consequently, there is need for proximate analysis of Amaranthus samples before the samples are used to ascertain their suitability as sources of iron in piglets depending on the locality.

7. Conclusion

The study has indicated that pigweed (Amaranthus) contains iron and can be used as a source of iron in piglets. The study has further revealed that the iron content differed significantly ($p<0.05$) among the three (3) Amaranthus species used in the current study. The Hybridus species was found to contain the highest (51%) of the total iron available in this study. Further studies on iron administration should be carried out to ascertain the potency of pigweed (Amaranthus) in the prevention of anaemia in piglets. There is need to trace the relationship of iron availability in soil type and the amaranthus species grown in a given locality.

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