The Feeding Value of Grain Amaranth as Influenced by Harvesting Stage

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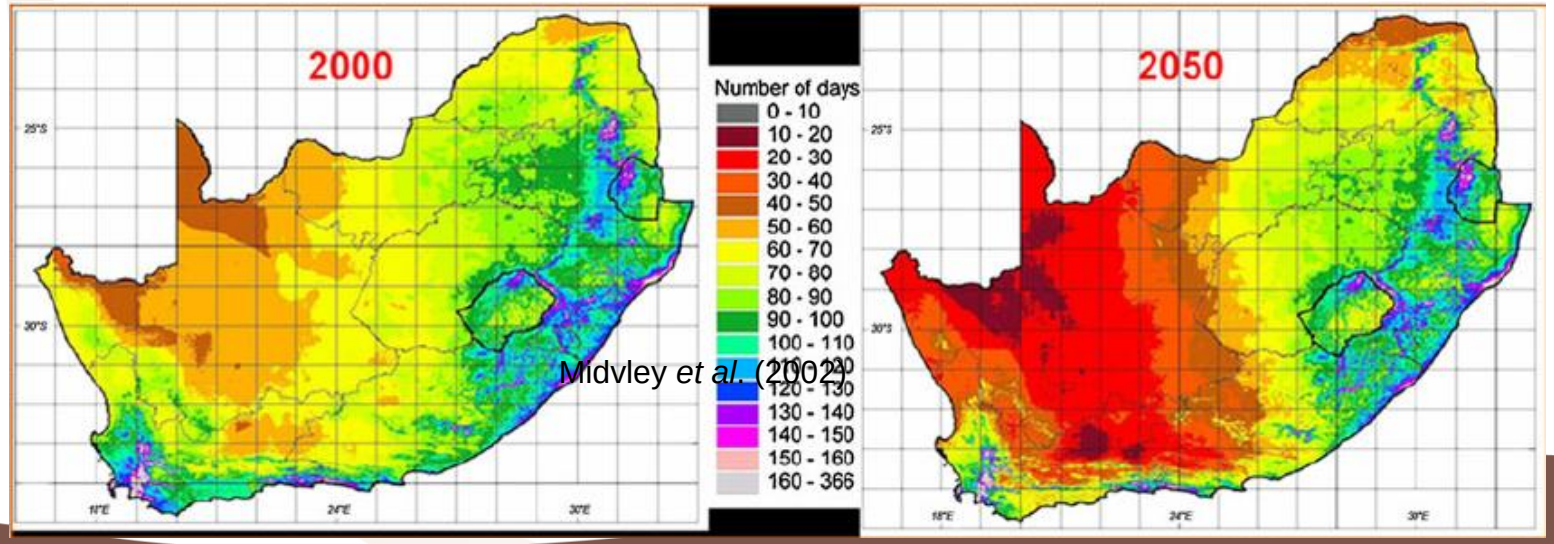
INTRODUCTION

- Protein as an ingredient comprises the most expensive input in livestock production (FAO, 2019).
- The livestock (poultry) industry currently faces a serious challenge in terms of protein source limitations.
- Climate change (Mangani *et al*., 2019).



Midvley *et al.* (2002)

INTRO CONTI….

- The potential value of climate smart crops.
- Amaranth is considered a highly nutritious (Manyelo et al., 2020).
- Abundant secondary metabolites.
- The objective of this study was to investigate the chemical composition of early and normal harvested amaranth grains as potential source of protein.

MATERIALS & METHODS

- *Amaranthus cruentus* grains were sampled from strip plantings at the Taung Experimental Farm (25º62’00’’S, 27º98’00’’E) in the Dr Ruth Segomotsi Mompati District of the North-West Province, South Africa.
- Planting was done through direct sowing in a sandy soil.
- Dual stage grain sampling was done from main inflorescences and related to the two digit phenological code of the Biologische Bundesanstalt, Bundesortenamt and Chemical Industry (BBCH) scale (Martínez-Núñez *et al.*, 2019).

Table 1 Important growth stages for *Amaranthus* spp. based on extended BBCH scale.

Two-digit BBCH Code	Stage description
00 to 09	Germination, dry seed to cotyledon emergence/ (omitted)
10	Cotyledons fully emerged
11	First pair of true leaves visible
12 to 19	Second pair of leaves visible to nineteenth pair and beyond
20	Lateral buds visible or expanded leaves without lateral stems
21	One side shoot visible
22 to 29	Two side shoots visible to 9 side shoots visible and beyond
30	Omitted (Stem elongation – coincides with leaf development)
40	Omitted (Development of harvestable vegetative parts)
50	Inflorescence present but enclosed by leaves
51	Enclosing leaves separated, inflorescence visible from above
59	Inflorescence visible, but all flowers closed.
60	Anthesis initiation (first visible anthers)
67	Early termination of anthesis (first senesced anthers)
69	Anthesis termination (all anthers senesced)
70	Fruit set (thickening first ovaries)
71	Ovule irregular translucent structure & mucoid consistency (stage 1)
73	Translucent soft textured (early-milky, contain white liquid) (stage 2)
75	Soft elliptic grain (white pasty content mid-milky stage) (stage 3)
77	Grain colour changes from translucent to opaque (late milk stage)
80	Grain maturation (soft dough – seed content dry but easily malleable)
85	Grain maturation (hard dough – seed content firm but pliable)
89	Grain maturation (ripe grain – seed content hard) (stage 4)
91	Senescence (basal leaves dry)
93	Senescence (lower half of main stem with dead leaves)

Figure 1 Translucent amaranth grain prior to growth stage 77 (Table 1).

M&M CONTI…..

DATA COLLECTION

- Proximate analysis (AOAC, 2010)
- Amino acids determination
- Determination of secondary metabolites

STATISTICAL ANALYSIS

- Data was subjected to a one-way ANOVA performed with SAS (2012) software.
- The Principal component analysis (PCA) was performed by using PAST version 4.02, (data manipulation, plotting, univariate and multivariate statistics analysis).

RESULTS & DISCUSSION

Table 2 Proximate analysis composition of premature and mature harvested grain amaranth (g/100g)

Nutrient	Grain maturity		SEM	Probability
	PHG	MHG		
DM	90.02	90.60	0.050	0.015
CP	18.16	18.26	0.050	0.293
CF	5.77[b]	6.91[a]	0.050	0.004
NDF	9.33[b]	11.08[a]	0.050	0.002
ADF	5.91[b]	7.24[a]	0.050	0.003
ADL	2.07	1.99	0.050	0.375
GE	17.47	17.55	0.050	0.375
EE	6.33[b]	7.75[a]	0.050	0.003
Starch	37.96[a]	29.11[b]	0.050	0.000
Ash	3.13	3.75	0.050	0.013

Values are means of duplicate analysed grain amaranth samples. [a. b:] Means followed by the same superscript in a row are not significantly different ($p > 0.05$). PHG: Premature Harvested Grains; MHG: Mature Harvested Grains

Table 3 Mineral composition of premature and mature harvested grain amaranth (mg/kg)

Nutrient	Grain maturity		SEM	Probability
	PHG	MHG		
Macro-minerals				
Calcium	2125.41[b]	2771.07[a]	0.05000	0.0001
Phosphorus	3966.24[b]	5024.56[a]	0.05000	0.0001
Magnesium	2805.53[b]	3501.36[a]	0.05000	0.0001
Potassium	4951.02[b]	5101.99[a]	0.03536	0.0001
Sodium	46.99[a]	29.45[b]	0.05000	0.0001
Trace-minerals				
Copper	6.95[a]	5.95[b]	0.05000	0.0050
Manganese	31.31[a]	23.71[b]	0.05000	0.0001
Iron	104.97[b]	147.01[a]	0.05000	0.0001
Zinc	59.96[a]	49.97[b]	0.05000	0.0001

Values are means of duplicate analysed grain amaranth samples. [a. b:] Means followed by the same superscript in a row are not significantly different ($p>0.05$). PHG: Premature Harvested Grains; MHG: Mature Harvested Grains

Table 4 Amino acid composition of premature and mature harvested grain (g/100g CP)

	Grains maturity			
	PHG	**MHG**	**SEM**	**Probability**
Essential amino acids				
Histidine	0.41[a]	0.41[a]	0.050	0.049
Arginine	1.60 [a]	1.60 [a]	0.050	0.001
Threonine	0.71[a]	0.67 [a]	0.050	0.058
Lysine	1.22 [a]	1.18 [a]	0.050	0.058
Tyrosine	0.56[a]	0.46 [a]	0.050	0.036
Methionine	0.21[a]	0.26 [a]	0.050	0.167
Valine	2.18 [a]	2.28 [a]	0.050	0.0003
Leucine	1.00 [a]	0.99 [a]	0.050	0.017
Non- Essential amino acids				
Serine	0.41 [a]	0.41 [a]	0.050	0.049
Glycine	1.60 [a]	1.60 [a]	0.050	0.0009
Aspartic acid	0.71[a]	0.67[b]	0.050	0.058
Glutamine	1.22 [a]	1.18 [a]	0.050	0.058
Alanine	0.56 [a]	0.46 [a]	0.050	0.036
Proline	0.21[a]	0.26 [a]	0.050	0.167
Isoleucine	2.18 [a]	2.28 [a]	0.050	0.0003
Phenylalanine	1.00 [a]	0.99 [a]	0.050	0.017

Values are means of duplicate analysed amaranth grain samples. [a. b:] Means followed by the same superscript in a row are not significantly different ($p > 0.05$). PHG: Premature Harvested Grain; MHG: Mature Harvested Grains

Table 5 Secondary metabolites of premature and mature harvested amaranth grain (mg/kg).

Secondary metabolites	Grain maturity		SEM	Probability
	PHG	MHG		
Rutin	26.30[b]	342.20[a]	0.000	0.0001
Hyperoside	0.00[b]	18.49[a]	0.007	0.0001
Tryptophan	27.34[b]	39.90[a]	0.010	0.0001
Quercetin3-O-rhamnosyl-rhamnosyl-glucoside	0.00[b]	0.96[a]	0.000	0.0001
Kaempferol rutinoside	1.82[b]	19.99[a]	0.010	0.0001

Values are means of duplicate analysed grain amaranth samples. [a. b:] Means followed by the same superscript in a row are not significantly different ($p > 0.05$). PHG: Premature Harvested Grains; MHG: Mature Harvested Grains

RESULTS CONTI…

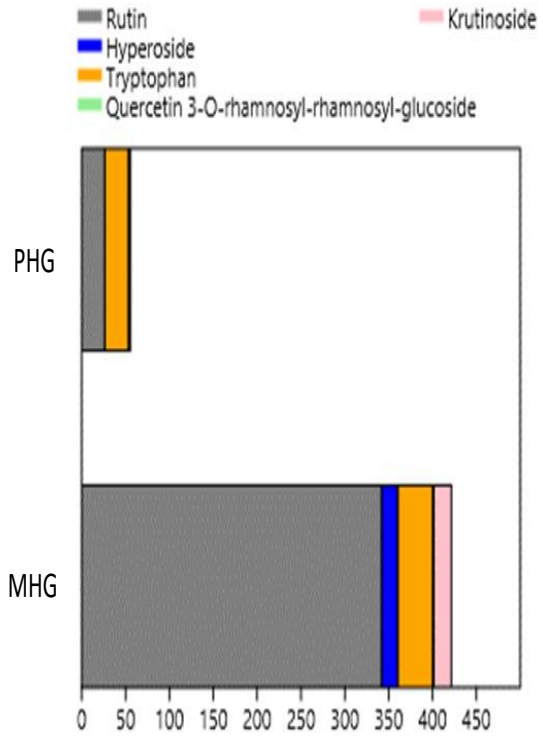


Figure 2. Stacked bar graph of secondary metabolites present in amaranth grains

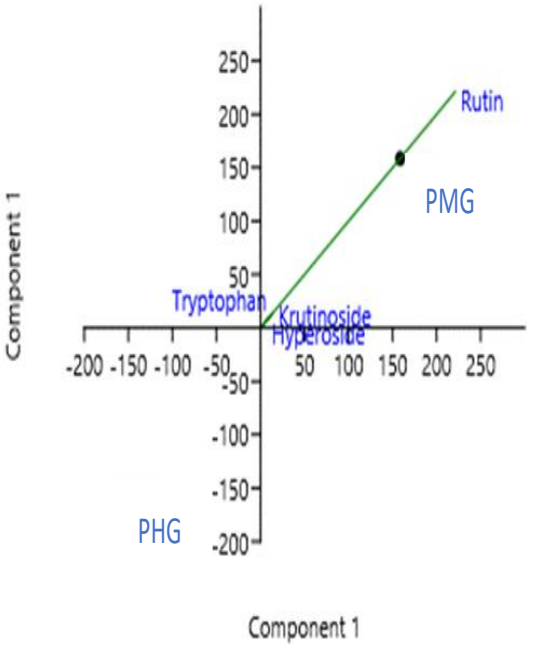


Figure 3. Principal component analysis (PCA) scatter plot for phenolic compounds.

CONCLUSIONS

- In conclusion, mature harvested grains had overall outstanding nutritional quality, even though amino acid composition was not affected by harvesting maturity.
- Secondary metabolites, specifically flavonoids, are shown to be abundant in mature harvested grains, which highlights its potential for enhancing immunity and gut function in chickens.
- Harvesting stage of amaranth grain will have an effect on its nutritive value and quality.

ACKNOWLEDGEMENTS

Agriculture & Rural Development
Department: Agriculture and Rural Development
North West Provincial Government
REPUBLIC OF SOUTH AFRICA

UNISA university of south africa

UNIVERSITY OF LIMPOPO

NRF National Research Foundation

Thank you

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