The use of crude protein content to predict concentrations of lysine and methionine in grain harvested from selected cultivars of wheat, barley and triticale grown in the Western Cape region of South Africa

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Abstract

Correlations were determined between the crude protein (CP) and lysine or methionine concentrations of grain from wheat (cultivar: *palmiet*), barley (cultivar: *clipper*) and triticale (cultivar: *usgen 19*) grown in the Western Cape region of South Africa. Twenty samples of varying CP content were collected for each grain type from different areas within the winter-rainfall sub-region. The relationships between CP content (x; percentage on an air-dry basis) and lysine concentration (y; percentage of CP) were as follows: (wheat) y = 6.380 - 0.198 x, (r^2 = 0.85); (barley) y = 6.003 - 0.167 x, (r^2 = 0.92); (triticale) y = 5.538 - 0.156 x, (r^2 = 0.75). The relationships between CP content (x; percentage on an air-dry basis) and methionine concentration (y; percentage of CP) were as follows: (wheat) y = 2.115 - 0.025x, (r^2 = 0.39); (barley) y = 1.527 - 0.030x, (r^2 = 0.59); (triticale) y = 1.581 - 0.022x, (r^2 = 0.31). It was concluded that the regression equations may be used as a rapid screening method for predicting the lysine and methionine content of South African wheat, barley and triticale grain from CP content.

Keywords: Lysine, methionine, crude protein, barley, wheat, triticale
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Introduction

Maize is an important ingredient of pig and poultry diets in South Africa. It is, however, considered an expensive commodity for pig and poultry producers in the Western Cape region as it is mainly grown in the northern parts of South Africa. Wheat, barley and triticale have been shown to be acceptable alternatives to maize in pig diets (Kritzinger & Olckers, 1985; Kemm, et al., 1986; Brand et al., 1995). It is important to optimise the utilisation of proteins provided by energy sources (i.e. cereal grains), as protein sources are more expensive. Maximum utilisation of grain protein will therefore reduce ration costs. It is essential to know the amino acid profile of ingredients used in diets formulated for monogastric animals, as a balanced amino acid profile in the final ration will have a protein-sparing effect. The primary limiting amino acid in cereal grains for growing pigs is lysine, followed by the sulphur-containing amino acids and threonine (Shimanda & Cline, 1974). It is therefore important to determine the contents of lysine and methionine in grain sources used for diet formulation. Because of considerable differences in chemical composition between different cultivars of wheat, barley and triticale produced at different locations (Champbell et al., 1995; Brand et al., 1997), the actual amino acid profiles of feeds are usually unknown. Although chromatographic methods can be used to determine the amino acid content of feedstuffs, they are expensive, time-consuming and are not always available to the producer. As a result, crude protein content is sometimes used to predict amino acid content using regression equations. Crude protein analysis is relatively inexpensive and is commonly performed in most agricultural analytical laboratories. It is not always acceptable to use regression equations from other countries or localities because differences exist between cultivars (Martin del Molino et al., 1989) and between grains produced under different agronomic conditions (Fuller et al., 1989). The aim of this experiment was to develop regression equations for use as a rapid screening method to predict lysine or methionine concentrations of grain from cultivars of wheat, barley and triticale produced in the Western Cape region of South Africa from crude protein (CP) content.

Materials and methods

Grains used in this study were: wheat (cultivar: *palmiet*), barley (cultivar: *clipper*) and triticale (cultivar: *usgen 19*). Twenty samples of each grain were collected from different locations in the Swartland and Rûens areas of the Western Cape. The grains are representative of those cultivated in the area. Protein content was determined by the Kjeldahl method (AOAC, 1984). Lysine concentrations were determined with a Beckman System 6300 High

Performance Analyser (Beckman Instruments Inc., Palo Alto, California) after acid hydrolysis in 6 N HCl. Methionine concentrations were determined using performic acid oxidation prior to hydrolysis and were quantified as methionine sulfone. Standard linear regression techniques (Snedecor & Cochran, 1980) were used to determine the relationship between the CP content and lysine or methionine concentration using Statgraphics 5.0 (1991).

Results

Mean values for CP, lysine and methionine concentrations of grains are presented in Table 1. There was considerable variation between the crude protein, lysine and methionine contents of individual samples.

Table 1 Minimum (min), maximum (max), mean (±SD) and coefficient of variation (CV) of the crude protein (CP), lysine and methionine content of selected winter grain samples (air dry basis).

Grain	n	Crude Protein (%)				Lysine (% of CP)				Methionine (% of CP)			
		Min	Max	Mean±SD	CV	Min	Max	Mean±SD	CV	Min	Max	Mean±SD	CV
Wheat	20	10.09	16.68	12.59±2.00	15.9	3.00	4.06	3.45±0.43	12.10	1.30	1.87	1.45±0.17	11.6
Barley	20	8.81	15.38	11.92±2.29	18.8	3.43	4.53	4.00±0.40	9.75	1.00	1.36	1.17±0.09	7.5
Triticale	20	9.00	16.26	12.73±2.24	17.2	3.16	4.45	3.55±0.40	11.08	1.15	1.52	1.30±0.09	6.7

The relationships between CP and lysine concentrations of wheat, barley and triticale are shown in Fig 1; the r^2 values were 0.85, 0.92 and 0.75 respectively. The relationships between CP and methionine concentrations for wheat, barley and triticale are shown in Fig 2; r^2 values were 0.39, 0.59 and 0.31 respectively. CP content was negatively related to lysine and methionine concentration in all cases.

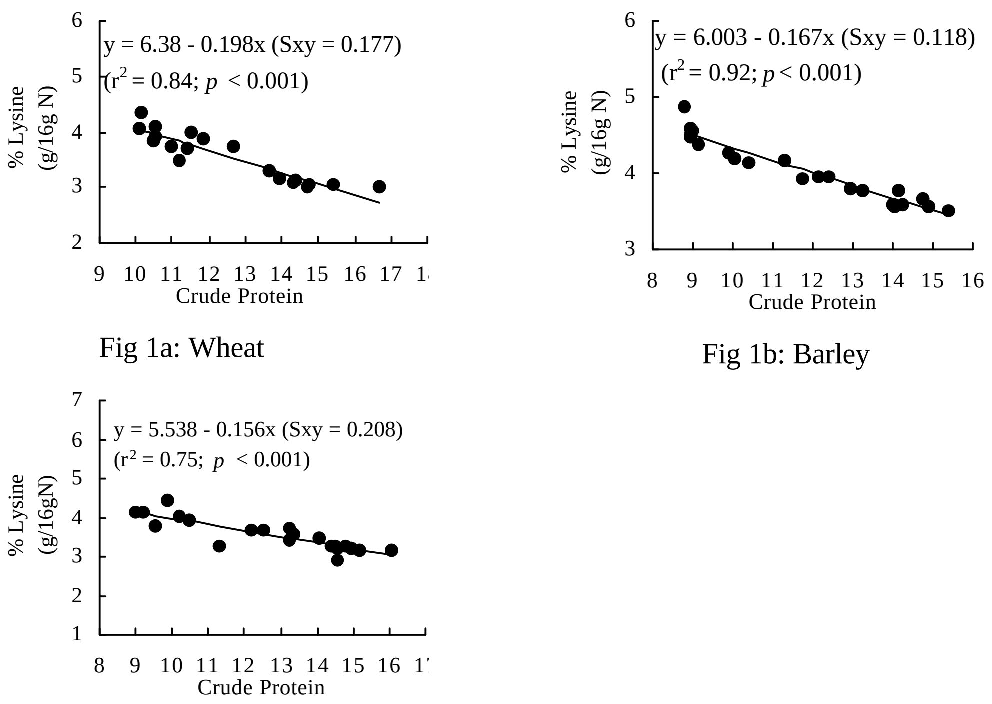

Fig 1a: Wheat

Fig 1b: Barley

Fig 1c: Triticale

Figure 1 The relationship between crude protein content and lysine concentration in the protein of selected samples of South African wheat, barley and triticale.

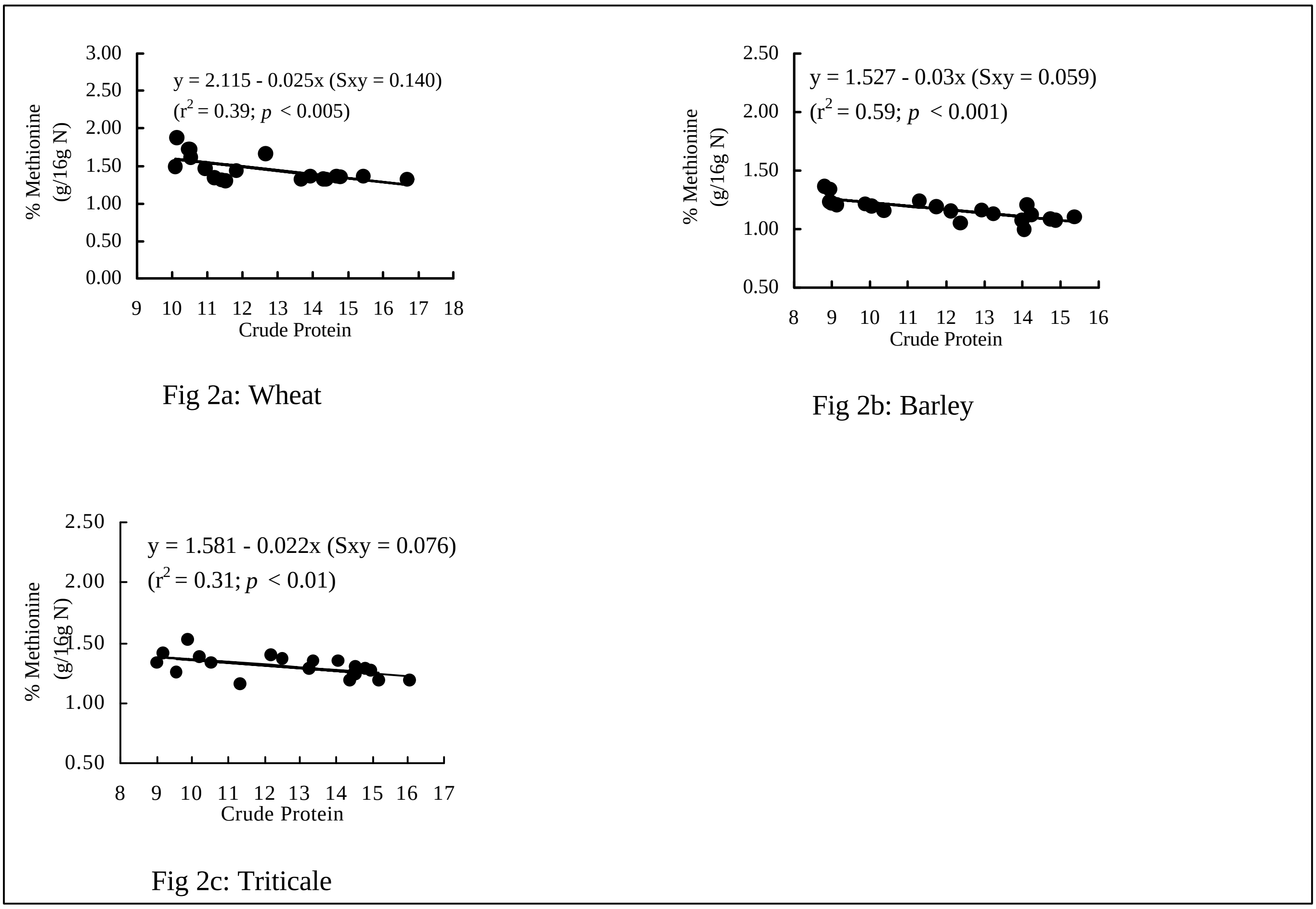

Figure 2 The relationship between crude protein content and methionine concentration in the protein of selected samples of wheat, barley and triticale.

Discussion

Variation between the CP contents of individual wheat samples was less than that reported by Kemm et al. (1986) for 112 wheat samples obtained from sites throughout South Africa (11.2-23.7%; dry matter basis). CP values of samples used for this study, however, corresponded well with values for 10 barley samples obtained from the Southern Cape (8.1-16.3%; Kritzinger & Olckers, 1985) and with values for triticale (9.9-19.5%; Brand et al., 1997). As in this study, other authors have also shown that protein content is inversely related to lysine content in wheat (r^2= 0.86, Batterham et al., 1976), triticale (r^2= 0.53, Radcliffe et al., 1986; r^2= 0.77, Rundgren, 1988) and barley (Fuller et al., 1989). According to Ward & Allendale (1988), several factors may affect CP content, and hence amino acid profiles. Higher-yielding varieties have a lower CP content (Pomeranz, 1981). Nitrogen fertilisation has been shown to increase CP content, but to have a negative effect on the content of most essential amino acids in the protein. The biological value of maize protein (Cromwell et al., 1983), wheat protein (Eppendorfer et al., 1985; Szúts et al., 1988) and sorghum protein (Eppendorfer et al., 1985) decreased as CP increased with high nitrogen fertiliser applications. This is due to an increase in the concentration of prolamine protein that has a low concentration of lysine, tryptophan and other essential amino acids (Ward & Allendale, 1988). In the case of triticale, a decline in the biological value of protein with increasing CP levels was associated with decreasing lysine content of protein (Rundgren, 1988). Sulphur deficiency will reduce protein quality; this is primarily due to a decreased concentration of the sulphur-containing amino acids, methionine and cystine (Ward & Allendale, 1988). Long storage periods can also negatively influence the CP and amino acid content of grains. Taverner et al. (1975) observed that the relative amounts of lysine in rust-damaged wheat increased as the total protein concentration decreased.

Conclusions

A negative correlation was shown to exist between CP content and the concentration of lysine or methionine (expressed as a percentage of crude protein content) in wheat, barley and triticale. It is suggested that the regression equations developed in this study may be used as a rapid screening method for predicting the lysine and methionine contents of selected cultivars of wheat, barley and triticale grain grown under local conditions from CP content.

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