VARIATION IN QUALITY OF MAIZE GRAIN DUE TO SOURCE, MOISTURE CONTENT AND PROCESSING

By

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DECLARATION

I, the undersigned, hereby declare that the work contained in this thesis is my own original work and it has not been submitted for any degree and is not currently being submitted for any other degree or qualification.

I certify that any help received in preparing this thesis and all sources used, have been acknowledged.

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Signature   Date 07/06/2010

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LIST OF ABBREVIATIONS

AEC	Animal ethics committee
AME	Apparent metabolizable energy
AMEn	Apparent metabolizable energy corrected for zero nitrogen
ANF	Anti-nutritive factor(s)
ANOVA	Analysis of Variance
AP	Alkaline phosphatase
APAF	Australian Proteome Analysis Facility
C. perfringens	*Clostridium perfringens*
CA	Chymotrypsin amidase
CFU	Colony forming unit
CP	Crude protein
cP	Centipoises
CV	Coefficient of variation
D	Day (s)
DE	Digestible energy
DM	Dry matter
DMRT	Duncan's multiple range test
DMSO	Dimethyl sulfoxide
EE	Ether extract
EU	European Union
FAO	Food and Agriculture Organization
FCR	Feed conversion ratio
FI	Feed intake
FTU	Phytase unit
GC	Gas chromatography
GE	Gross energy
GIT	Gastrointestinal tract
GLM	General linear model
GMD	Geometric mean diameter
GSD	Geometric standard deviation
H	Hour(s)

HM	High maize (750 g/kg diet)
HMM	High-moisture maize
HPLC	High performance liquid chromatography
ICP	Inductive coupled plasma
IP6	Inositol hexaphosphate
LM	Low maize (250 g/kg diet)
LMM	Low-moisture maize
LW	Live weight
LWG	Live weight gain
ME	Metabolizable energy
MIL	Maize inclusion level
Min	Minutes
MM	Medium maize (500 g/kg diet)
MQ	MilliQ water
Mt	Million tonne
NMR	Nuclear magnetic resonance
NRC	National Research Council
NS	Non-significant
NSP	Non-starch polysaccharide(s)
Ppm	Parts per million
QLD	Queensland
RS3	Resistant starch type three
S	Second(s)
SCD	Sealed chamber digestion
SCFA	Short chain fatty acid
SEM	Standard error of mean
TiO_2	Titanium dioxide
TME	True metabolizable energy
TMEn	True metabolizable energy corrected for zero nitrogen
UK	United Kingdom
UNE	University of New England
USA	United States of America
USGC	United State Grain Council

LIST OF PUBLICATIONS

Refereed Journal Articles-

M. M. Bhuiyan, A. F. Islam and P. A. Iji (2010). Variation in nutrient composition and structure of high-moisture maize dried at different temperatures, South African Journal of Animal Science, 40 (3), 190-197.

M. M. Bhuiyan, P. A. Iji and A. F. Islam (2010). Effect of drying tempeture and microbial enzyme supplementation on the nutritive value of high moisture maize, World's Poultry Science Journal, Vol **66,** Supplement, p363.

M. M. Bhuiyan, A. F. Islam and P. A. Iji (2010). Response of broiler chickens on diets based on high-moisture maize grain subjected to artificial drying and supplementation with microbial enzymes, South African Journal of Animal Science (In Press).

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M. M. Bhuiyan, P. A. Iji, A. F. Islam and L. L. Mikkelsen (2009). Response of broiler chickens to increasing levels of maize grain and supplementation with a microbial enzyme. Proceedings of the Recent Advances in Animal Nutrition, Australia, Vol **17**: p196.

M. M. Bhuiyan, P. A. Iji, and L. L. Mikkelsen (2009). Effects of grain source, comminution technique and particle size on nutritive value, feed utilization and growth of broiler chickens. Proceedings of the Australian Poultry Science Symposium, Vol **20**: p123.

SUMMARY

The aim of this project was to identify the major changes in the physiochemical composition of maize grain when subjected to different processes and response of broiler chickens on diets containing such grains. Source of grain, stage of harvest, milling technique, particle size, dietary inclusion level, and supplementation with microbial enzymes were investigated, in terms of grain physicochemical quality and nutritive value to broiler chickens. Feeding trials were conducted on male Cobb broiler chicks from day-old through to 21-day of age in each instance. All feed was provided as mash and experiments were conducted in environmentally controlled housing. Each experimental chapter has been presented as a stand-alone research paper. This summary provides an outline of the thesis and an overview of the key findings of the research.

Chapter 1 provides background information and highlights the importance of the topic of research. This is followed by a review of literature in Chapter 2, covering the use of cereal grains, with particular emphasis on maize, as a source of energy in broiler chicken diets. The review covered factors that affect grain quality, namely, grain type, source, variety, post-harvest processing, and microbial enzyme supplementation.

In Chapter 3, the chemical composition and ultra-structure of maize from three sources were assessed, as received or after heat treatment over varying time periods. These variables were affected by heat treatment, primarily as a result of the reduction in moisture content. In particular, the maize starch quality declined, as indicated by an increase in amylose and decrease in amylopectin and digestible starch contents. However, the phytate-P content was also reduced and the *in vitro* nutrient digestibility slightly increased as a result of the heat treatment of maize in contrast to untreated maize.

Chapter 4 presents results of the performance of broiler chickens on diets prepared from maize from different sources, subjected to different milling techniques and milled to different particle sizes. There were no major effects of these treatments on feed intake, growth or feed conversion efficiency of broiler chickens. A key finding was the increase in feed intake in early life (up to day 7) on fine particle diets. Coarse particle size

stimulated gizzard development at a later age, as revealed by assessment at 21d of age. Milling technique and particle size of the milled material will not greatly influence the value of maize in diets for broiler chickens.

In the experiment reported in Chapter 5, relatively high levels of maize (50 % and 75 % compared to 25 %) in diets caused significant increases in feed intake, body weight and better FCR. Supplementation with microbial enzymes led to further improvements. The relative weights of the small intestine, liver and proventriculus plus gizzard were increased in chickens on diets containing higher levels of maize. The results suggest that maize grain can be used at very high levels in the diet without detriment to productivity, particularly when supplemented with microbial enzymes. This will enable reduction in the inclusion levels of more expensive protein meals.

The physicochemical properties of early-harvested maize are presented in Chapter 6. Such maize was dried naturally under the sun or artificially, at varying temperatures. The physiochemical composition, in particular the starch quality, was reduced and morphology of the grains was changed by artificial drying, and these effects were more pronounced at 100 °C than under sun-drying or drying at 80 and 90 °C. In particular, the starch quality (amylopectin content) was reduced by oven drying of high-moisture maize while amylose content was increased. The dried maize was subsequently used in a feeding trial, and this is reported in Chapter 7.

Bird performance was adversely affected by drying grains at high temperature (Chapter 7). The birds grew better on diets based on the sun-dried grains. Exogenous enzyme supplements did not markedly improve growth on diets containing grains dried at 80 and 100 °C but there was some response on diets containing grains dried under the sun or dried at 90 °C.

The implications of the overall findings from this project are discussed in Chapter 8, along with recommendations for grain processors and the poultry industry, and areas of future research were identified.

To sum up, it is clear that there is a significant variation in the quality of maize grain and many other factors are responsible for these differences. The source of maize and the milling technique do not have much influence on its nutritive quality. It is obvious that maize grain can be used at a much higher level than is currently the case in the industry. Maize quality, in particular starch quality, is reduced by heat treatment, especially of high-moisture grains. Such maize should be dried artificially at less than 100 °C and its nutritive value sustained by adding an appropriate enzyme cocktail to the diets.

There is a need for future research into processing and use of high-moisture maize grains, especially when held in long-term storage after drying. A wider range of microbial enzymes should be tested on such maize and the effects of diets with this kind of grain on mucosal morphometry and digestive function of birds should be assessed.