THE INFLUENCE OF BREED AND GENDER ON THE MOISTURE-TO-PROTEIN RATIO OF DRY-PLUCKED CHICKEN AND CHICKEN PORTIONS IN SOUTH AFRICA

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Abstract – This study is the first of a series that are envisaged to determine whether the moisture to protein (M/P) ratios can be used to monitor the level of extraneous water added during the slaughtering and chilling processes to Individually Quick Frozen (IQF) chicken portions, as well as subsequent brine injection at levels allowed by proposed legislation.

Physiological M/P ratios (excluding all extraneous water) of whole, reconstituted (2x breasts, 2x thighs, 2x wings and 2x drumsticks, but excluding the keel), and breast, drumstick and wing portions were examined. All portions contained associated bone and skin. The influence of breed and gender was also investigated.

Seventy-two Cobb and 72 Ross chickens were used in the study, half of each being males and the other half females. A third of each group was analysed as whole chicken, a third as reconstituted chicken and a third as portions.

In the combined whole and reconstituted chickens the M/P ratio of the males (3.95) were significantly higher ($p<0.0001$) than that of the females (3.83). No other significant differences were found. The practical implication of this difference still needs to be established.

Regarding M/P ratio of portions, drumstick ratio (3.84) was a highly significantly ($p<0001$) higher than those of breast (3.53) or wing (3.57) which did not differ significantly from each other. Gender and breed had no significant influence ($p>0.05$) on the M/P ratios of the portions.

Key Words – breast, Cobb, drumstick, poultry, Ross, wing

I. INTRODUCTION

In South Africa poultry has become a very important protein source in the daily diet of its population, accounting to about 60% of the animal protein consumed [1]. Individually quick frozen (IQF) portions have become an important component of the poultry industry.

During the processing of chicken extraneous moisture or water is absorbed by the carcass. In Europe a maximum of 6% extraneous water is allowed whilst in South Africa 8% extraneous water is allowed in whole carcasses. However, In South Africa, the current legislation also allows an additional 4% to be injected in breast cuts that absorbed less than 4% water during spin chilling [2] as amended [3]. Brine injection of other chicken portions is currently not allowed.

To monitor the moisture absorption in chicken portions, the European Union (EU) has established moisture to protein ratios [4]. The maximum limits of water to protein (W/P) levels in Table 1 are allowed for the different chilling methods of different cuts in the EU.

Table 1: EU highest extraneous water levels and highest permissible W/P ratios [4]

Cut	Air chilling (2% extraneous water)	Air-spray chilling (4% extraneous water)	Immersion chilling (6% extraneous water)
Breasts	3.40	3.50	3.60
Thighs & drumsticks	4.05	4.15	4.30

In 2010 a newspaper report highlighted certain practices by poultry processors [5], and resulted in various investigations into these practices. In February 2011 it was found that brine injection into IQF portions is a common practice, and that some of the drumstick samples may have been injected with brine up to a level of 90% [6]. As a result of these findings the Department of Agriculture, Forestry and Fisheries has commissioned a project to determine the

appropriate W/P ratios for monitoring extraneous moisture in chicken portions, including allowable brine injection levels in IQF portions.

The South African Poultry Association (SAPA) subsequently initiated a project in which M/P ratios will be established for physiological moisture content in chicken and chicken portions, and to establish the influence of each of the processing practice on these ratios. These practices include the different chilling systems, as well as subsequent brine injection and different levels of brine injection.

This report is the first report on the SAPA initiated research project, and reports on the physiological water to protein content of whole and reconstituted chicken, and the breast, drumstick and wing portions.

II. MATERIALS AND METHODS

The number of chickens slaughtered in each group was as follows:

Table 2: Chickens used per category in this project

Group	Cobb		Ross	
	Males	Females	Males	Females
Whole chicken	12	12	12	12
Reconstituted chicken	12	12	12	12
Chicken to be portioned	12	12	12	12

The chickens were slaughtered at a small commercial abattoir on the same day of arrival at the abattoir. Gender was determined by abattoir personnel, and the males separated from the females. The chickens were slaughtered according to normal practice, with the exception that they were dry-plucked, and eviscerated without being rinsed or washed.

After slaughter, the whole chicken designated carcasses were weighed and placed in marked plastic bags. For the reconstituted chicken group, chickens were commercially portioned (9 portions) into breasts (B), thighs (T), drumsticks (D), wings (W) and the keel. A reconstituted chicken consisted of randomly selected 2xB, 2xT, 2xD and 2xW. The different portions were each weighed separately, and combined as a reconstituted chicken in a marked plastic bag. As this study was based on commercial practices, samples were not anatomically portioned, but portioned according to commercial practices. All portions contained associated skin and bones.

Chickens carcasses selected for the portioned group were weighed, and portioned into B, T, D, W and the keel. The portions were each weighed and the sets of portions (2xB, 2xT, 2xD and 2xW) placed in separate plastic bags.

All samples were frozen at -20 °C until further analysis.

Samples were removed from the freezer and immediately prepared for homogenisation.

Whole frozen chickens were cut using a band saw (Okto) into slices of *ca*. 1.5 cm thickness, which were homogenised in a 6 blade bowl cutter (Okto 20 l. The sample was then frozen until analysed.

Frozen reconstituted chickens consisting of 2xB, 2xT, 2xD and 2xW had been frozen together. The frozen conglomerate was cut using a band saw into slices of approximately 1.5 cm thickness (Okto) and homoginised as for whole chicken, and kept frozen until analysed.

Frozen chicken portions (either 2xB, 2xT, 2xD or 2xW) were cut using a band saw into slices of approximately 1 cm in thickness (Okto). The slices were homogenised in a 6 blade bowl cutter (Scharfen 5 l) until completely homogenised and being of a fine consistency. The sample was frozen until analysed.

Proximate analysis was conducted by an ISO/IEC 17025 laboratory. Subsamples of the frozen samples were freeze dried, and the subsequent sample used for the determination of moisture, fat (petroleum ether extraction), protein (Kjeldahl, using a factor of 6.25 to convert nitrogen to protein) and ash. All results were calculated on a wet basis. The M/P ratios were calculated by dividing the moisture content by the protein content.

Please note that the thigh results are not included in this paper as the proximate analysis results were not available at the time the paper was prepared.

III. RESULTS AND DISCUSSION

The average weights of the warm carcasses used in this project are given in Table 3, and is based on the warm carcasses of the carcasses of the chickens used as whole carcasses, and those of the reconstituted carcasses before portioning.

Table 3: The average weight (g) and standard deviation of the males and females of each breed

Breed	Female		Male	
	Average	sd	Average	sd
Cobb	1219.6	177.5	1370.0	177.2
Ross	1363.7	162.0	1464.5	137.1

Analyses of the whole carcasses and reconstituted carcasses indicated that breed and sample (whole or reconstituted) did not differ significantly ($p<0.05$) (Table 4). Neither did any of the interactions. However, gender did differ significantly ($p<0.0001$). The females had a lower M/P value (3.83) than the males (3.95) (Table 5). The practical implications of this finding is currently not known, and comparative results have not been found in the literature.

Table 4: Results of statistical analyses of the factors breed, gender and sample (whole or reconstituted chicken) on the M/P ratio

Source	DF	F	Pr > F
Breed	1	0.329	0.5680
Gender	1	30.236	**<0.0001**
Sample	1	0.440	0.5088
Breed x Gender	1	1.107	0.2957
Breed x Sample	1	0.058	0.8110
Gender x Sample	1	0.938	0.3356
Breed x Gender x Sample	1	1.432	0.2347

Regarding the chicken portions, breed and gender did not have a significant influence ($p>0.05$) on the W/P ratios, as well as any of the interactions (Table 6). However, Portion resulted in significant differences ($p<0.05$).

Table 5: M/P ratios of the different breeds, gender and samples (whole or reconstituted chicken)

Variable		M/P			M/P	
Breed	Cobb	3.90	a	Ross	3.88	a
Gender	Female	3.83	a	Male	3.95	b
Sample	Whole	3.90	a	Reconstituted	3.88	a

[ab] Superscripts in the same row that differ indicate significant ($p<0.05$) differences

Table 6: Results of statistical analyses of the factors breed, gender and portion (breast, drumstick and wing) on the M/P ratio

Source	DF	F	Pr > F
Breed	1	2.578	0.1107
Gender	1	0.090	0.7644
Portion	2	60.676	**<0.0001**
Breed x Gender	1	3.498	0.0637
Breed x Portion	2	0.421	0.6573
Gender x Portion	2	0.308	0.7353
Breed x Gender x Portion	2	0.986	0.3756

The drumsticks had a significantly higher W/P ratio (3.84) than those of the breasts (3.53) and wings (3.57) (Table 7). The drumstick ratio is higher than that found in 1993, but lower than that of 2012 in the EU [7]. In those studies the W/P ratios of the drumsticks were 3.770 (1993) and 3.958 (2012). Complicating the comparison is that in the EU studies the breast fillets did not contain skin or bone, which the current study in South Africa did contain. The current South African breast M/P ratio is higher than that for the EU in 1993 (3.191) and 2012 (3.270) (Table 8). Wings were not included in the EU study.

IV. CONCLUSION

It seems that the use of the M/P ratios in the EU has been successful, and should therefore also be successful in South Africa. As the EU study [7] indicates that the ratio may change with time due to genetic changes in the chicken, it is important to develop specific M/P ratios for South Africa to take the local environment and practices into account. Also these values should take cognisance of the proposed legislation to allow brine injections into portions to a certain

injection level and that the local M/P ratios are developed to determine the total content of extraneous water.

Table 7: M/P ratios of the different breeds, gender and samples (whole or reconstituted chicken)

Breed	Gender	Portion
Cobb	Female	Breast
3.63 [a]	3.64 [a]	3.53 [a]
Ross	Male	Drumstick
3.67 [a]	3.65 [a]	3.84 [b]
		Wing
		3.57 [a]
[ab] Superscripts in the same column that differ indicate significant differences($p<0.05$)		

Table 8: Comparison of M/P ratios for breast and drumstick portions in South Africa and the EU (1993 and 2012 [7])

	Current South African study	EU 2012	EU 1993
Breast	3.53	3.270 *	3.191 *
Drumsticks	3.84	3.958	3.770
*Excludes skin and bone			

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