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The variation in milk composition from individual ß-lactoglobulin AA and BB phenotype cows

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ABSTRACT

Studies in New Zealand have shown that bulk milk collected from groups of ß-lactoglobulin AA phenotype cows has a different composition to bulk milk collected from groups of ß-lactoglobulin BB phenotype cows (Hill, 1993). Although all cows used in this study were different to those used by Hill (1993), differences in composition were similar with the ß-lactoglobulin AA phenotype cow group producing milk which contained less casein, fat and total solids than ß-lactoglobulin BB phenotype cow group. No significant difference was observed in the total protein, lactose or ash content in the milk of the two phenotype groups. In comparison with the ß-lactoglobulin AA and BB phenotype bulk milks, large variations in composition were observed in the milk from individual cows. As all cows were fed on identical pasture and subjected to identical farm management practices these results indicate that in addition to ß-lactoglobulin phenotype other genetic factors can have a significant influence on the composition of milk.

Keywords: Milk composition; ß-lactoglobulin phenotypes.

INTRODUCTION

The relationship between milk protein phenotypes and milk composition has been the focus of many studies.

Excellent reviews on this subject have recently been produced by Ng-Kwai-Hang and Grosclaude (1993) and Jacob (1993). Although the phenotypes of ß-lactoglobulin (ß-LG) have been the most intensively studied in this respect, their relationship with milk protein content is still the subject of debate (Jacob, 1993).

Studies in New Zealand have shown that the milk collected from the ß-LG AA phenotype cows contained less fat, casein and total solids, but more whey protein than the milk collected from the ß-LG BB phenotype cows (Hill, 1993). No differences were observed in the content of total protein between the milks of the ß-LG AA and BB phenotype cows, a result consistent with studies performed in Australia (McLean *et al.*, 1984) and Holland (van den Berg *et al.*, 1992, Bovenhius *et al.*,1992). However some studies have found that the concentration of total protein is higher in the milk supplied from ß-LG AA phenotype cows than in the milk supplied by ß-LG BB phenotype cows (Aschaffenberg and Drewry, 1957, Cerbulis and Farrell, 1975, Feagan *et al.*, 1972, Ng-Kwai-Hang *et al.*, 1984, 1990).

This current work examines the relationship between milk composition on an individual cow basis and compares the results with those of bulk milk samples.

METHODS

To further explore the relationship between ß-LG phenotypes and New Zealand milk composition a mixed herd of approximately 200 ß-LG AA and 200 BB phenotype cows (Friesian, Jersey, Ayrshire and cross-bred cows) was established. All cows used in this study were different to those used by Hill (1993) as was the farm and pasture location. Cows were calved during spring 1992 (synchronized lactation) and were located on a large factory supply dairy farm in the Manawatu. Cows were fed solely on pasture and milked as a mixed herd to eliminate feed difference, stocking rate and milking variables from the experiment.

Milk collection was performed essentially as described by Hill (1993), with the exception that a dual milk line was used instead of the Ruakura Milk Harvester for milk segregation.

The composition of milk from the ß-LG AA and BB phenotype was analyzed (in triplicate) twenty times throughout the 1992/93 season (August 1992 to April 1993) using the methods described by Hill (1993). From the herd 43 ß-LG AA Friesian and Friesian-cross phenotype cows and 46 ß-LG BB Friesian and Friesian-cross phenotype cows were selected at random for composition analysis. On March 2 1993 morning and afternoon milk samples were collected from these cows using the Livestock Improvement Corporation Herd Test Analysis service. A composite of the morning and afternoon milk samples was then analyzed in triplicate using the methods described by Hill (1993).

RESULTS AND DISCUSSION

Table 1 shows the average differences in milk composition in bulk milk samples collected from the groups of ß-LG AA and BB phenotype cows throughout the 1992/93 season. Results are very similar to those of the previous study (Hill, 1993) which used only Friesian cows. The bulk milk from the ß-LG BB phenotype group contained an average of 9 % more fat and 3 % more total solids than the bulk milk from the ß-LG AA pheno–type group. But as in the previous study no significant differences were observed in the total protein and lactose contents between the milks of the two phenotype groups. Similarly the milks from the two phenotype groups contained the same level of ash, a result consistent with previous findings (Hill *et al.*, 1993).

TABLE 1: Differences in composition of bulk milks collected from ß-lactoglobulin AA and BB phenotype cows during the 1992/93 season.

Milk Component %	ß-Lactoglobulin Phenotype AA x	sd	Range	BB x	sd	Range
Protein	3.14	0.18	2.89–3.53	3.16	0.18	2.89-3.67
Fat	4.13	0.43	2.87-4.93	4.51	0.39	3.87-5.86
Lactose	4.58	0.18	4.10-4.93	4.61	0.22	4.37-5.86
Ash	0.73	0.03	0.67-0.80	0.73	0.02	0.69-0.77
Total Solids	12.69	0.44	12.05-13.66	13.10	0.65	12.27-14.51
		(N=20)			(N=20)	

A detailed description of the variation in composition of milk from ß-LG AA and BB phenotypes with season will not be dealt with here, but is part of an ongoing study. Marked seasonal fluctuations in composition were observed as indicated by the range in the values of milk components shown in Table 1. The differences in milk composition produced by the two phenotypes appeared to be relatively insensitive to these seasonal fluctuations, e.g. in early season (18.8.92) the content of protein in the ß-LG AA and BB phenotype bulk milks was 3.4 and 3.47%, in mid season (9.11.92) 3.15 and 3.13% and in late season (23.4.93) 3.4 and 3.43%.

Tables 2 and 3 show the differences in composition between ß-LG phenotype milks determined in individual Friesian and Friesian-cross milk samples. As was found in the analysis of the bulk milks, the average levels of fat and total solids were higher in the milks from the subpopulation of ß-LG BB phenotype cows than those found in the milks from the subpopulation of ß-LG AA phenotype cows. Again no differences were observed in the average protein contents between the two phenotype groups.

TABLE 2: Differences in composition between milk collected from individual ß-lactoglobulin AA and BB phenotype Friesian cows.

Milk Component %	ß-Lactoglobulin Phenotype AA x	sd	Range	BB x	sd	Range
Protein	3.25	0.31	2.69–4.08	3.25	0.24	2.69-3.86
Fat	3.91	0.92	1.96-5.46	4.11	0.64	2.59-5.23
Lactose	4.67	0.25	3.94-5.15	4.81	0.19	4.37-5.33
Ash	0.66	0.06	0.54-0.78	0.65	0.13	0.50-0.75
Total Solids	12.49	2.47	10.75-14.98	12.82	0.79	11.08-14.26
		(N=31)			(N=35)	

The milks from different cows of the same phenotype can have large differences in composition (Tables 2 and 3). These differences, were equal to or greater than seasonal variations in the compositions of the ß-LG AA and BB phenotype bulk milks (Table 1). Thus, although the ß-LG phenotype can be used to explain some of the differences in composition observed between individual cows, other factors still have a major influence on milk composition. It is interesting that although in general these studies show that ß-LG BB phenotype cows produce milks containing more fat and total solids, a ß-LG AA phenotype cow produced milk with the highest levels of fat and total solids of all the Friesian and Friesian-cross cows that were tested.

TABLE 3: Differences in composition between milk collected from individual ß-lactoglobulin AA and BB phenotype Friesian-cross cows.

Milk Component %	ß-Lactoglobulin Phenotype AA x	sd	Range	BB x	sd	Range
Protein	3.49	0.36	3.19–4.34	3.52	0.32	2.83-4.22
Fat	3.64	0.80	2.21-4.92	3.99	0.84	2.19-4.85
Lactose	4.73	0.27	4.20-5.09	4.85	0.29	4.32-5.34
Ash	0.69	0.06	0.58-0.77	0.67	0.06	0.55-0.73
Total Solids	12.55	0.82	11.48-14.04	13.03	0.84	11.34-13.99
		(N=12)			(N=11)	

The protein to fat ratio is higher in the milk from ß-LG AA phenotype cows (Table 4). However, as with individual milk components, the large protein:fat variation in the milks from individual animals (Table 4), was greater than the seasonal variation of this ratio in the bulk milks produced from ß-LG AA and BB phenotype cows.

TABLE 4: Differences in the protein to fat ratios in ß-lactoglobulin AA and BB phenotype bulk milks and from individual ß-lactoglobulin AA and BB phenotype cows.

ß-Lactoglobulin Phenotype	Bulk Milk x	Range	Individual Friesian Cows x	Range	Individual Friesian-Cross Cows x	Range
AA	0.75	0.66-1.07	0.83	0.63-1.69	0.96	0.64-1.57
BB	0.70	0.57-0.81	0.79	0.52-1.31	0.88	0.66-1.75

CONCLUSIONS

Differences in composition between bulk milks collected from ß-LG AA or BB phenotype cows throughout the 1992/93 season were similar to those observed in a 1991 study (Hill, 1993, Hill *et al.*, 1993). Thus, farm, herd and breed selection do not appear to have a major influence on the results as all these factors were different in this current study to those used in the 1991 study.

No differences were observed in the average protein contents of individual or bulk milks produced by ß-LG AA and BB phenotype cows. Although this result confirms previous findings in New Zealand (Hill, 1993) and is consistent with Dutch and Australian results, it contradicts the findings from other studies and particularly the major studies performed on Canadian dairy herds (Ng-Kwai-Hang *et al.*, 1990). The reasons for these apparent geographical differences in results are at present unclear and are the subject of current investigations.

Although ß-LG phenotype can go some way towards explaining why different cows produce milk with different component contents, other factors still have a major influence on milk composition. Consequently although ß-LG AA phenotype cows generally produce milk with a lower content of total solids than ß-LG BB phenotype cows, individual ß-LG AA phenotypes can be found which will produce milk containing a high concentration of total solids.

Studies should be undertaken to establish how ß-LG phenotype influences the composition of milk, and how the ß-LG gene interacts with other factors (both genetic and non-genetic) during the synthesis of milk components.

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