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The quality of eggs on farms and at retail outlets in north Queensland during summer and winter

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Summary

Eggs from 23 farms and 45 retail outlets in north Queensland were examined for external and internal quality during surveys in Townsville and Cairns in both February and June, 1981. Relative differences between size grades were established in a preliminary experiment, so that the main survey concentrated on large (55 to 60 g) eggs.

The albumen quality of farm eggs was below the 82 Haugh units recommended for freshly laid eggs, with a mean of 70.6 in summer and 71.8 in winter. At the retail level, eggs averaged 54.8 Haugh units in summer and 60.8 Haugh units in winter with 60.3% of summer eggs and 38.8% of winter eggs having less than 60 Haugh units.

The incidence of underweight eggs and of soiled eggs was relatively high, but percentages of eggs with obviously cracked shells or with inclusions of blood or meat spots were low. A few farms supplying Townsville contributed a large proportion of pale yolks. Management and egg handling practices on farms were surveyed but no practice was shown to influence egg quality at the farm level.

INTRODUCTION

Egg quality can be defined in relation to shell structure; the presence or absence of blood spots and of microbial spoilage; and, the physical condition, colour, flavour, whipping and baking qualities of the yolk and white. The consistency of the egg albumen, however, is recognised as an indication of freshness of the egg. In fresh eggs the thick albumen clings tightly to the yolk, whereas in stale eggs the white becomes thin and disperses over a wide area. Where both accuracy and ease of measurement are required for the assessment of albumen quality these differences can be expressed as the Haugh unit which is a function of egg weight and albumen height (Hughes 1972). This index is widely used as a measurement of quality in survey work.

Temperature and duration of the marketing period are the most important factors governing the quality of albumen in eggs available to consumers (Jensen and Stadelman 1952; Coote *et al.* 1966). The effect of season on the albumen quality of eggs has been clearly demonstrated by egg quality surveys in several Australian states and in New Zealand.

Coote *et al.* (1966) measured the albumen quality of eggs at the different stages of marketing from farm to retail shops during all seasons of the year in 1960 to 1963 in Sydney and in February, 1961 in Brisbane. Only during the cooler months of April to October did eggs at retail outlets have an average quality that reached or exceeded the modest standard of 60 Haugh units.

R. J. Hughes (pers. comm. 1983) conducted a series of 14 surveys of eggs from retail stores in Adelaide from 1971 to 1980. Haugh unit averages ranged from 51 to 63 in summer and from 62 to 67 in winter.

Surveys of albumen quality at retail outlets in Queensland have been carried out in Brisbane in winter 1975 and summer 1976 (Pugh and Compton 1977) and in summer 1978 (K. D. Pugh, pers. comm. 1978) and in Rockhampton in both summer and winter 1978 (K. D. Pugh, pers. comm. 1979). Average Haugh units for 55 to 60 g eggs were 58.9,

50.3, 53.3, 54.9 and 60.0, respectively. The corresponding percentages of eggs below 60 Haugh units were 51.0, 74.8, 63.8, 62.3 and 39.7.

Eggs of higher quality would be expected at the farm than at retail outlets. In New Zealand (Anon. 1977*b*) found that 15% of farm eggs scored below 60 Haugh units in September and 47% scored below 60 in February. Surveys of retail stores in six major cities showed that 27% of eggs scored below 60 Haugh units during September. The corresponding figure in February was much higher at 72% (Anon. 1977*a*; 1977*b*).

The environment in north Queensland differs substantially from that where studies of egg quality have been conducted. It is characterised by very high temperatures and relative humidity in summer and warm temperatures in winter. These factors contribute to faster rates of deterioration in egg quality. A wide geographical spread of egg producers and the absence of a central marketing authority at the time of this study are further distinguishing features, which increase the unevenness in quality of eggs available to the consumer. Delivery schedules, storage conditions and quality control are the responsibility of each producer individually, so that quality, from the consumer's point of view, is influenced most by the standards of the worst producer. Coupled with these characteristics, is a lack of information on the quality of eggs reaching consumers in north Queensland.

This paper expands these results to tropical environments by reporting findings of egg quality investigations in north Queensland. Haugh unit values for the four major egg grades were compared. Surveys of egg quality then were conducted at both the farm and retail levels. Relationships between management and egg handling practices on farms and Haugh units were also examined.

MATERIALS AND METHODS

Environment

The study was carried out on eggs from farms supplying Townsville and Cairns and at retail outlets in the urban areas of these two cities. Average daily minimum and maximum temperatures, the lowest and highest values recorded and the average relative humidity at 3 p.m. during the fortnight preceding each survey period are given in Table 1. These values are typical for summer and winter in north Queensland.

Table 1. Temperatures and relative humidity recorded during the fortnight preceding each survey period

	Season	Average minimum °C	Average maximum °C	Lowest minimum °C	Highest maximum °C	Average r.h.* %
Townsville	Summer	25.0	31.0	23.3	33.2	74.2
	Winter	14.7	24.7	9.2	27.8	47.4
Cairns	Summer	24.9	31.7	23.7	33.7	70.2
	Winter	15.6	25.8	12.8	27.1	52.6

*r.h.=relative humidity.

Sampling

In the comparison between small (45 to 50 g), standard (50 to 55 g), large (55 to 60 g) and extra large (60 g and above) eggs, eight dozen cartons were sampled from each grade offered for sale at two supermarkets in Townsville during February, 1981.

For the farm survey, four dozen freshly-collected, large eggs were randomly selected from each farm. Eleven farms from the Townsville district and twelve from the Cairns district participated in February 1981, while nine from each area participated in the follow-up survey in June 1981. Farm numbers in the first survey represented 82% of commercial producers in north Queensland.

To determine quality at the retail level, eggs were sampled from 30 outlets in Townsville and from 15 in Cairns. The numbers sampled reflected the relative populations of the two cities. Six outlets in Townsville and three in Cairns were supermarkets. Outlets were selected at random from separate lists of supermarkets and small shops and independent selections were made for each of the February and June 1981 surveys. Four, dozen cartons of large eggs were sampled from those displayed for sale at each of these outlets.

Measurement of egg quality

To determine Haugh units, eggs were weighed and then broken onto a glass plate. The height of the thick albumen was measured equidistant between its outer edge and the outer edge of the yolk. Yolk colour was measured under fluorescent lighting and scored by visual comparison with a 15 value Roche colour fan. Yolks corresponding to colours of six or less were classified as pale. Inclusions of blood and meat spots were noted when clearly visible. Cracked shells were defined as those which could be detected by eye since eggs were not candled. Eggs were classified as soiled if manure, dirt or broken egg material could be seen adhering to shells. Variability was measured in two ways. Standard deviation was calculated between means for cartons from the same source. Variability within a carton was estimated by standard deviation from differences between individual eggs within a carton.

Farm egg handling practices

Management and egg handling practices on farms were surveyed for 21 of the 23 farms which participated in the summer study. Information collected was:

- the number of times eggs were collected on each day;
- the collection method;
- the time between collection and packing;
- the use of candling;
- washing of eggs;
- the packing method;
- use of a cool room on the farm.

Information on quota size served as an index for scale of operations. Regression and analysis of variance techniques were used to test the relationships between any of these factors and albumen quality measured for these farms.

RESULTS

Comparison between grades

Results of the comparison between four grades in Townsville during Summer are given in Table 2. Albumen quality declined with increased size of the egg and, with the exception of standard and large, all pairwise differences between grades were significant ($P<0.01$). The percentage of eggs with Haugh unit values less than 60 followed the same pattern. Values for individual cartons indicate that the worst carton (for each grade) contained very poor quality eggs but that eggs of reasonably good quality were available from all grades except extra large. Variability between cartons was substantially higher than that within cartons for all grades, but each of these measures was homogeneous across grades.

Farm and retail outlet surveys

Albumen quality results for summer and winter surveys in Townsville and Cairns are summarised for farms, supermarkets and small shops in Table 3. Farm samples were measured within 24 hours of lay except for Townsville in summer when the measurement period was up to 48 hours after the egg had been laid. These latter samples gave lower mean Haugh unit values and higher percentage of eggs less than 60 Haugh units than

samples for other farm eggs. Differences in mean Haugh units between farms were significant ($P<0.05$). Variability between cartons was similar to that within cartons for farm eggs as would be expected for eggs which have been recently packaged from a single day's production.

Table 2. Albumen quality (Haugh units) for four grades of retail eggs in Townsville during summer 1981

Grade	Mean Haugh units	s.d.	Within carton s.d.	Per cent <60 Haugh units	Lowest carton mean	Highest carton mean
Small	66.5	23.49	7.14	18.7	44.0	74.2
Standard	57.3	21.28	7.64	57.3	42.5	64.1
Large	55.9	28.17	9.80	61.5	42.2	66.6
Extra large	45.3	21.98	12.14	89.6	38.1	55.8

Table 3. Albumen quality (Haugh units) for farm and retail eggs in Townsville and Cairns during summer and winter 1981

Source	Season	Number of dozen eggs	Mean Haugh units	s.d.	Within carton s.d.	Per cent <60 Haugh units	Lowest carton mean	Highest carton mean
Farms								
Townsville	Summer	44	68.0	9.81	9.83	19.4	57.0	79.4
	Winter	36	71.0	12.84	9.59	9.3	59.4	78.0
Cairns	Summer	48	72.9	8.65	8.19	9.9	56.1	81.5
	Winter	36	72.6	12.47	7.71	10.4	55.8	87.3
Supermarkets								
Townsville	Summer	24	54.6	23.49	10.03	62.9	32.6	66.6
	Winter	24	61.6	15.75	10.61	34.4	50.2	66.9
Cairns	Summer	12	56.8	18.62	9.47	58.0	43.0	67.7
	Winter	12	65.0	14.34	7.28	25.0	57.3	73.7
Small shops								
Townsville	Summer	95	55.3	23.49	10.03	59.2	26.5	79.4
	Winter	91	58.0	15.75	10.61	49.3	38.4	72.9
Cairns	Summer	46	53.3	18.62	9.47	62.0	31.0	70.9
	Winter	48	64.6	14.34	7.28	24.7	41.9	74.0

Average Haugh unit values for retail eggs in north Queensland rose from 54.8 in summer to 60.8 in winter while percentages of eggs less than 60 Haugh units fell from 60.3 in summer to 38.8 in winter.Improvements in quality from summer to winter were less for small shops in Townsville than for small shops in Cairns and quality in supermarkets was similar to that in small shops, with average Haugh unit values of 59.0 and 57.4, respectively and corresponding percentages less than 60 Haugh units of 46.3 and 50.5. Between carton variability was substantially higher than within carton variability from all retail eggs.

Results for other aspects of egg quality are summarised in Table 4. The incidence of eggs with obviously cracked shells and with inclusions of blood and meat spots was uniformly low. However, the incidence of undersized eggs and ones with soiled shells was high. There was a higher proportion of eggs with pale yolks in Townsville than in Cairns.

The effects of egg handling practices

Egg handling practices on the 21 north Queensland farms surveyed were quite variable. From Monday to Saturday, eggs were collected once per day on 5 farms, twice per day on 7 farms and more frequently than this on 9 farms. On Sunday, eggs were not collected at all on 8 farms, collected once on 6 farms and more frequently on 7 farms. Baskets

were used to collect eggs on 6 farms, fillers on 14 farms and a conveyer belt on 1 farm. Eggs were packed immediately on 8 farms, within 4 hours of collection on 7 farms and after a longer period than this on 6 farms. Candling was used on 8 farms but not on the remaining 13. All eggs were washed on 6 farms and soiled eggs only on 15 farms. Eggs were cooled prior to packing on 4 farms. Cool rooms for egg storage were available on 11 farms. None of these factors was significantly related to quality of freshly collected eggs from farms. Similarly, albumen quality was not affected by quota size.

Table 4. Quality of eggs surveyed in Townsville and Cairns during summer and winter 1981 as percentages of underweight, obviously cracked, soiled, inclusions and pale yolks

Source	Season	Under-weight	<53 g	Obviously cracked	Soiled	Inclusions	Pale yolks
Townsville	Summer	44.6	19.6	1.4	12.1	3.8	35.8
	Winter	25.5	4.8	0.9	15.2	3.1	29.4
Cairns	Summer	51.2	22.9	0.3	9.1	3.0	2.0
	Winter	39.1	13.1	0.6	12.0	3.0	9.8

DISCUSSION

The relative quality of grades

Differences in albumen quality between the four grades of eggs are a reflection of larger, poorer quality eggs as birds get older. Hill and Hall (1980) found that Haugh unit values declined from 82.0 at 26 to 30 weeks of age in a curvilinear fashion to 74.0 at 74 to 78 weeks while egg weight increased from 54.6 g to 62.8 g during the same period. Muir *et al.* (1976) found a steady decline in Haugh units from 85.1 at 33 weeks of age to 72.3 at 72 weeks coupled with a corresponding increase in egg weight. A New Zealand survey found that size 5 eggs (minimum weight 44 g) were of better quality than size 6 (53 g) and size 7 (62 g) eggs. The percentage of eggs with Haugh unit values less than 60 were 16.3, 30.3 and 36.0, respectively (Anon. 1977*a*). Although these results are comparable to those for Townsville for the smaller eggs, differences between grades are more pronounced in Townsville for larger eggs. Relative differences in average Haugh units between grades in Townsville are similar to those obtained in Brisbane and Rockhampton (Pugh and Compton 1977; K. D. Pugh, pers. comm. 1978, 1979). Hence, trends established in our major survey using larger grade eggs may reasonably be extrapolated to all eggs in north Queensland.

The quality of eggs at the farm

Coote *et al.* (1966) found that the average quality of eggs in Sydney at the time of laying was good with an average Haugh unit value of 82. Eighty-three percent of farms produced eggs having Haugh unit values exceeding 77, a value which Coote *et al.* considered to be the minimum quality acceptable for satisfactory marketing. Seasonal variation in albumen quality of freshly laid eggs was found to be slight. In contrast research in New Zealand established that 15% of farm eggs laid during winter and 47% of eggs laid during summer had Haugh unit values of less than 60. These results could, in part, be explained by the time elapsing between lay and measurement which was at least two days (Anon. 1977*b*). In the present study seasonal variation in farm eggs was slight. Eggs from three farms in summer and from two in winter had average Haugh units exceeding 77. The overall average Haugh units for farm eggs in north Queensland of 71 was much lower than both the average of 82 Haugh units and recommended minimum values of 77 Haugh units (Coote *et al.* 1966). However, eggs from the best farms did exceed these values, indicating that high quality eggs can be produced on farms in north Queensland during all seasons of the year.

Quality at the retail outlets

Comparable quality studies at retail outlets have been carried out at Rockhampton (K. D. Pugh, pers. comm. 1979), Brisbane (Pugh and Compton 1977), Sydney (Coote *et al.* 1966), Adelaide (R. J. Hughes, pers. comm. 1983) and in New Zealand (Anon. 1977*a*; 1977*b*). Mean Haugh unit values and percentages of eggs less than 60 Haugh units for these studies have been set out in Table 5 to facilitate comparison with results from the present survey. Albumen quality during winter in north Queensland is inferior to that recorded for Sydney, Adelaide and New Zealand. With this exception, albumen quality in north Queensland is at least as high as that recorded elsewhere.

Table 5. Comparative results of average Haugh units and percentage of eggs less than 60 Haugh units for retail eggs during summer and winter from several surveys in Australia and New Zealand

Source	Place	Years	Mean Haugh units		Per cent <60 Haugh units	
			Summer	Winter	Summer	Winter
Present study	North Qld.	1981	54.8	60.8	60.3	38.8
Pugh, pers. comm. 1979	Rockhampton	1978	54.9	60.0	62.3	39.7
Pugh and Compton 1977	Brisbane	1975–78	51.9*	58.9	69.2*	51.0
Coote *et al.* 1966	Sydney	1960–62	53.4*	65.4*		
Hughes, pers. comm. 1983	Adelaide	1971–80	56.6*	65.2*		
Anon. 1977*b*	New Zealand	1976–77			72.0	27.0

* Where several separate surveys have been carried out, the simple average of results has been quoted.

However, these simple comparisons do not take into account the temperatures to which eggs were exposed during the marketing period. In Sydney the mean temperatures were 22°C in summer and 13°C in winter (Coote *et al.* 1966) while maximum temperatures in New Zealand centres during the 14 days before the breakout tests averaged 23°C in summer and 14°C in winter (Anon. 1977*b*). Temperatures for Adelaide would be expected to be of the same order as these and those for Brisbane and Rockhampton would approach those for north Queensland (Table 1). Since temperature is a major factor affecting albumen quality (Coote *et al.* 1966), it might be more reasonable to compare results for winter in north Queensland with those for summer in Sydney, Adelaide and New Zealand.

Differences between types of retail outlets

The albumen quality of eggs from supermarkets was only marginally better than that of eggs from small shops. In New Zealand supermarket eggs were fresher than eggs from other shops, (Anon. 1977*a*), but no differences between types of retail outlet were found in Brisbane (Pugh and Compton 1977) or in Adelaide (Hughes, pers. comm. 1983).

Quality decline during storage and marketing

Rates of decline of egg quality during storage and marketing are most affected by temperature and duration of storage and marketing. Under ideal storage conditions Hill and Hall (1980) found that eggs declined from 85.0 to 66.8 Haugh units over 14 days. In a simulation of marketing in New Zealand, farm eggs with an average Haugh unit value of 79 declined to a score of 71 Haugh units when delivered to the shop five days later, fell to 58 Haugh units after three days on the shelf and to 48 Haugh units on the seventh day of shop storage (Anon. 1977*a*). Hughes (1975) found that egg quality fell by 23.7 Haugh units in summer and 14.5 Haugh units in winter over 12 days under actual marketing and seasonal conditions in Adelaide when cool rooms were not used. Declines of the order of 30 Haugh units in summer and 10 Haugh units in winter were recorded during marketing in Sydney (Coote *et al.* 1966). In the present survey there was a difference

between farm and retail eggs of 15.8 Haugh units in summer and 11.0 Haugh units in winter. Changes in the percentages of eggs having less than 60 Haugh units was 45.9% in summer and 28.9% in winter. Since temperatures in north Queensland were much higher than in Sydney or New Zealand, the smaller loss of quality between farm and retail outlets in north Queensland could perhaps be explained by a shorter period between production and availability to the consumer.

Sources of variation

Eggs packed into the one carton could be expected to come from the same batch of hens, to have been laid and collected at the same time and to have passed through the same handling conditions during marketing. Given this situation, it is reasonable to expect that variability within a carton, measured by standard deviation, would be similar for farm and for retail eggs and for summer and winter samples as found in this study. Coote *et al.* (1966) also found similar within-sample variability across 34 samplings involving farms, grading floor and retail outlets. Their within-sample standard deviations ranged from 7.12 to 14.56 compared with a range of 7.28 to 10.61 for the present study. Variability between cartons and within cartons was similar for farm eggs reflecting similar history and handling conditions for batches of eggs on the farm. For eggs at retail outlets, the higher variability between cartons than within cartons might reflect the different sources of eggs and different handling conditions during marketing and, particularly, different ages of eggs on display for sale.

Conformity to weight grades

The incidence of eggs weighing less than the minimum weight of 55 g for large grade eggs was high during all aspects of the north Queensland surveys. Loss of weight during marketing and slight inaccuracies during grading could not fully explain these high levels since 34.7% of the underweight eggs weighed less than 53 g. The percentage of underweight eggs was lower in Adelaide with an average of 15.7% (R. J. Hughes, pers. comm., 1983), in Brisbane with an average of 15.6% (Pugh and Compton 1977) and in Rockhampton with an average of 24.9% (K. D. Pugh, pers. comm. 1979). Smaller eggs generally have higher albumen quality, so that differences in the proportion of underweight eggs could be expected to influence comparisons between surveys of albumen quality. Hence, such comparisons could unduly favour the present survey.

Other egg quality defects

Although the number of soiled eggs was high overall, the distribution across sources of eggs was not uniform. High values from a few farms disproportionally affected this overall figure. Similarly, a few farms in Townsville contributed most of the pale yolks.

The influence of egg handling practices

Egg handling practices on north Queensland farms varied; however, none of these was related to quality of freshly collected farm eggs. This was not surprising since there was insufficient time between laying and measurement for these factors to exert their influence. Significant relationships might have been found had eggs been sampled at the point of delivery to either the retail outlet or the marketing agent.

CONCLUSIONS

This study provides a set of bench-marks for quality of eggs produced in north Queensland. As indicated by the quality of the best cartons sampled, high quality eggs can be produced on commercial farms in north Queensland in all seasons of the year. Good quality eggs were also available to consumers through retail outlets. However, mean Haugh unit values fell well short of this potential, particularly in the case of eggs from retail outlets. This indicates that, in general, improved management and egg handling practices are required on farms and at other points in the marketing system.

A limitation to achieving this is the lack of a financial incentive for individuals to consistently market high quality eggs. While it is clearly to the benefit of the industry as a whole for each individual to maintain high standards of quality, altruism is not in the individual's short term interest when costs are involved in maintaining high quality. A marketing and grading system which remunerates good quality and penalises poor quality should lead to improved quality of eggs available to consumers and could also stimulate consumption of eggs.

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