IODINE VALUE AND SOFTENING POINT AND CHURNING TEMPERATURE OF SOME QUEENSLAND BUTTERFATS

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SUMMARY.

Iodine values and softening points were determined for three years on samples of butter collected fortnightly from 12 centres representing the main dairying districts of Queensland.

Seasonal variations of these two values were markedly uniform on an all-centres basis. Individual centres exhibited less uniform variations between seasons because of differing conditions of feed and animals. Varying conditions of feed and stage of lactation of the milch animal contributed to the seasonal nature of variations between years and among centres.

The all-centres average iodine value was 37.1. Fluctuations throughout the three years ranged from minimum average values of 34.6–35.6 in the January–March quarter to maximum average values of 38.8–39.5 in the July–August months. The iodine value of individual samples ranged from 31.7 to 42.5.

The all-centres average softening point was 33.7 deg. C. Variations throughout the three years ranged from minimum average values of 32.6–33.3 deg. C. in the August–September months to maximum average values of 33.9–34.5 deg. C. during the summer–autumn period of December–May. The softening point of individual samples ranged from 31.0 to 36.4 deg. C.

There was a significant negative correlation between the iodine value and the softening point of butterfat.

The correlation between iodine value and total vitamin A potency was positive and significant.

An examination of cream churning temperatures revealed no relationship between this aspect of butter manufacturing operations and variations in the composition of butterfat as represented by the values of iodine value and softening point. The incidence of body and texture defects in butters suggests that more attention should be given to this relationship.

I. INTRODUCTION.

Butterfat production in Queensland shows marked seasonal trends, with maximum production in late summer (January–March). McDowall (1953) reported that in all States of Australia other than Queensland maximum production is from spring to early summer (September–December). Dairy cattle in Australia are dependent on pasture for the bulk of their feed requirements. Further, lactation periods are arranged generally to coincide with the time of maximum pasture growth. Thus, the level of butterfat production in any of the Australian States is related to the seasonal distribution of rainfall in that State. In Queensland the greater proportion of annual rainfall is during the summer months, whereas the southern States record important winter and spring rainfall.

A further variation in production levels within Queensland occurs as a consequence of widely varying climatic conditions. In some years climatic conditions are characterised by State-wide drought periods and in almost every year dry periods occur in localities in many major dairying districts. The influence of these varying conditions is reflected in varying quality and quantity of pastures and crops available to the grazing animal and the adoption of alleviating farm management practices. These variations in the plane of nutrition also cause changes in the chemical composition of butterfat.

Physical defects in Queensland butters are also of a marked seasonal nature. Although not severe in comparison with overall defects, they are of sufficient magnitude to warrant some form of specialised processing in factories. Rice (1956) reported a serious incidence of these defects in 4 per cent. of all choice grade supplies examined during the period January 1955 to June 1956. The major faults were "mottle," evident during the October-March period, and "open-ravelly," which occurred in the April-June quarter.

McDowall (1953) reviewed investigations into alterations of manufacturing technique to coincide with variations in the composition of butterfat to ensure satisfactory body and texture in butter. He indicated variations in iodine value and variations in softening point of fats as two of the main factors determining the correct cooling techniques and churning temperatures of cream for butter manufacture.

The investigation reported in this paper was undertaken to determine iodine values and softening points in butterfats from 12 dairying centres in Queensland for the years 1954, 1955 and 1956. The degree of variation within years and between years was determined. The possible causes of these variations are discussed.

Cream churning temperatures of each sample were obtained as an indication of the degree of manufacturing control applied.

II. DESCRIPTION OF DAIRYING DISTRICTS.

The dairying industry of Queensland is contained largely in the coastal and subcoastal areas from the border of New South Wales northwards to Rockhampton, the Darling Downs plateau and the Atherton Tableland. Most of the butter production is from the southern portion of the coastal and subcoastal strip.

To ensure that butterfats examined were representative of the varying climatic conditions throughout Queensland, butter samples were obtained from 12 centres within five districts. These districts are listed below with a brief description of the main agricultural characteristics and dairy management practices:—

(*a*) *Atherton Tableland* is represented by one centre, Malanda. The predominant pasture species of the dairying region are paspalum, kikuyu and molasses grasses, with white clover available in the higher rainfall areas. Some oats and cowcane are used as supplementary green fodders in the dry spring period. Feeding of grain and protein meal is practised on a limited scale. The annual rainfall varies between 40 and 60 in.

(*b*) *Port Curtis* is represented by one centre, Gladstone. The pastures are mainly of native grasses, but there are some stands of Rhodes grass. Lucerne, oats, Sudan grass and millets are grazed during the winter-spring months. No concentrate feeding is practised. The annual rainfall varies between 30 and 40 in.

(*c*) *Burnett–West Moreton* is represented by four centres, Biggenden, Murgon, Kingaroy and Grantham. The predominant pasture species are Rhodes grass, paspalum, green panic and native grasses. Supplementary grazing of Sudan grass, lucerne, maize and millets is practised, but few farmers feed concentrates. The annual rainfall varies between 30 and 40 in.

(*d*) *Wide Bay–East Moreton* is represented by three centres, Gympie, Caboolture and Beaudesert. The pastures are mainly paspalum and kikuyu grasses, with some Rhodes grass and native grasses on the better forest country. Sorghum, Sudan grass, field pea and oats provide the bulk of the supplementary grazing. Lucerne is grazed and concentrates are fed in the Beaudesert area. The annual rainfall varies between 40 and 50 in.

(*e*) *Darling Downs* is represented by three centres, Chinchilla, Toowoomba and Warwick. Except in the Chinchilla area, where native pastures predominate, most of the grazing is on crops. Fodder crops are mainly oats and some early wheat, together with smaller acreages of Sudan grass, lucerne and sorghum. The annual rainfall in this district is relatively low and varies between 20 and 30 in.

III. ANALYTICAL METHODS.

(1) Sampling of Butters.

The method of sampling butters is presented by Gartner (1959), who examined the same samples for carotene and vitamin A.

Data concerning the type and condition of pastures, nature and extent of any general supplementary feeding and cream churning temperatures accompanied each sample.

The limitations of sampling factory butters for analyses because of varying cow numbers have been detailed by McDowell and McDowall (1953). For general survey purposes, however, this method is satisfactory.

Sampling was commenced in January 1954 and concluded in December 1956.

Totals of 715 determinations for iodine value and 760 determinations for softening point were made.

(2) Analyses.

Butterfat samples were prepared by melting butter in an oven at 45 deg. C., decanting the clear butterfat layer into centrifuge tubes, and centrifuging for 2–3 min. at a speed of approximately 2,000 r.p.m. (17 in. diameter). The clear upper portion was retained for analysis.

Iodine value was determined by Wijs' method, using ICl_3 for the preparation of the stock iodine solution as described by Bolton (1928). Samples of 0·45–0·55 g. of butterfat were analysed, using 100 per cent. excess of reagent. The reaction was allowed to proceed in the dark for ½–1 hr. Samples were analysed in duplicate and results agreed within 0·2 units.

Softening point was determined by the method of Barnicoat (1944).

Table 1.

Average Iodine Value and Range of Values of Butterfats from Individual Centres.

District.	Centre.	Year. 1954. Av.	1954. Range.	1955. Av.	1955. Range.	1956. Av.	1956. Range.
Atherton Tableland ..	Malanda ..	38·4	35·4–41·8	*	37·0–41·2	38·2	36·5–40·2
Port Curtis	Gladstone..	35·1	31·7–40·6	37·8	34·2–40·6	36·6	32·0–39·8
Burnett–West Moreton	Biggenden	*	31·7–40·0	37·6	32·8–39·9	*	32·2–39·3
	Murgon ..	35·8	33·4–39·5	37·1	34·1–39·6	36·8	33·3–40·7
	Kingaroy ..	36·2	34·2–39·1	37·4	34·1–40·8	37·6	35·2–39·4
	Grantham	36·2	32·9–40·1	37·0	34·8–40·1	37·5	35·4–39·4
Wide Bay–East Moreton	Gympie ..	36·5	33·4–40.2	36·7	33·1–39·5	36·5	32·4–39·4
	Caboolture	36·8	34·0–40·2	37·4	34·4–39·5	36·3	33·5–38·4
	Beaudesert	38·4	33·3–42·2	39·6	36·1–42·5	39·0	35·8–41·5
Darling Downs ..	Chinchilla..	36·3	32·0–40·0	36·9	35·1–38·9	37·9	34·2–40·9
	Toowoomba	36·0	32·8–41·0	36·8	34·2–39·5	36·8	34·9–39·2
	Warwick ..	36·6	32·8–42·3	37·2	34·9–39·0	38·2	35·2–41·9
All Centres	..	36·5	31·7–42·2	37·5	32·8–42·5	37·3	32·0–41·9

* Results for Malanda (1955) and Biggenden (1954 and 1956) are incomplete.

IV. RESULTS.

(1) Iodine Values.

(a) Individual Centres.

Average results and the range of iodine values of samples from individual centres for the three annual periods are listed in Table 1 and Figs. 1–4. Marked seasonal variations in values were apparent, with minimum values in summer months and maximum values in winter months.

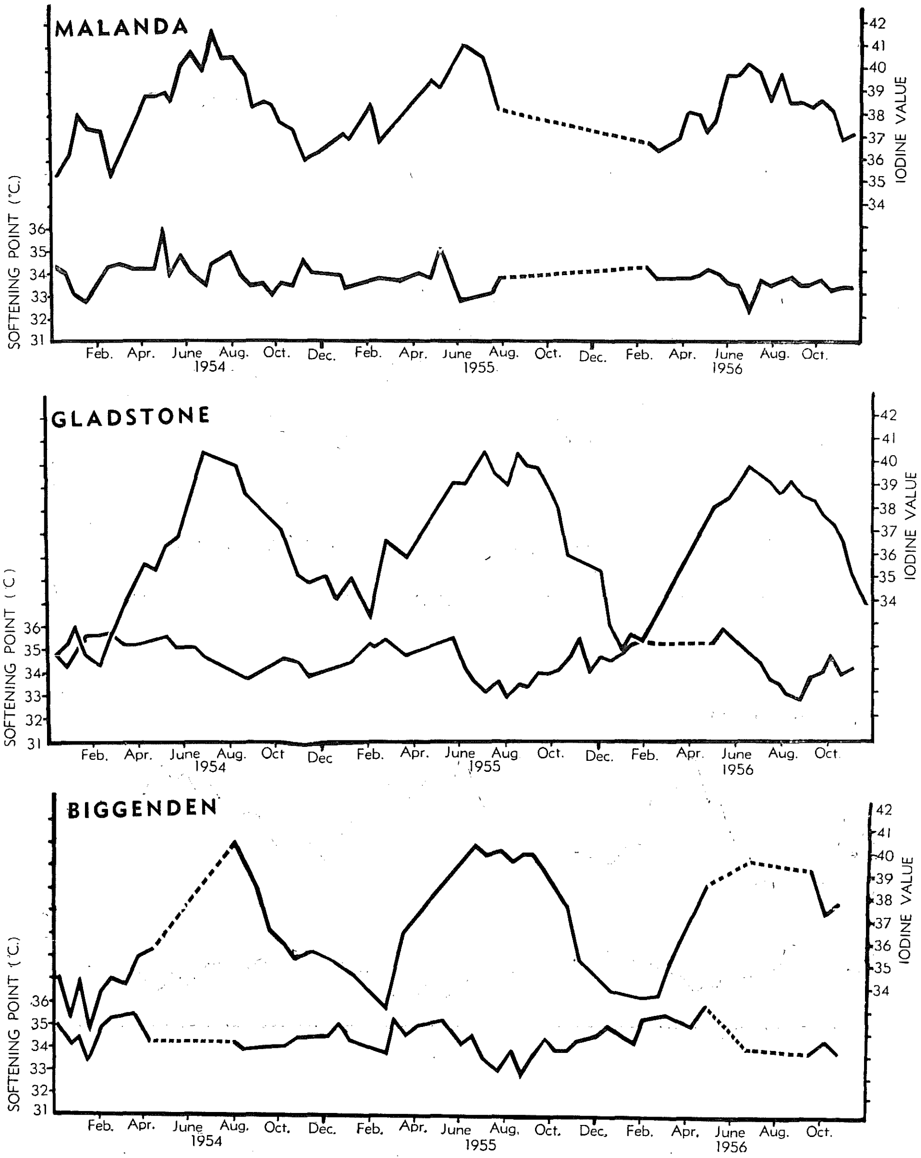

Fig. 1.

Softening Points and Iodine Values for Butterfats from Malanda, Gladstone and Biggenden.

In several centres iodine values showed wide fluctuations between consecutive samples. These variations are illustrated graphically in Figs. 1–4.

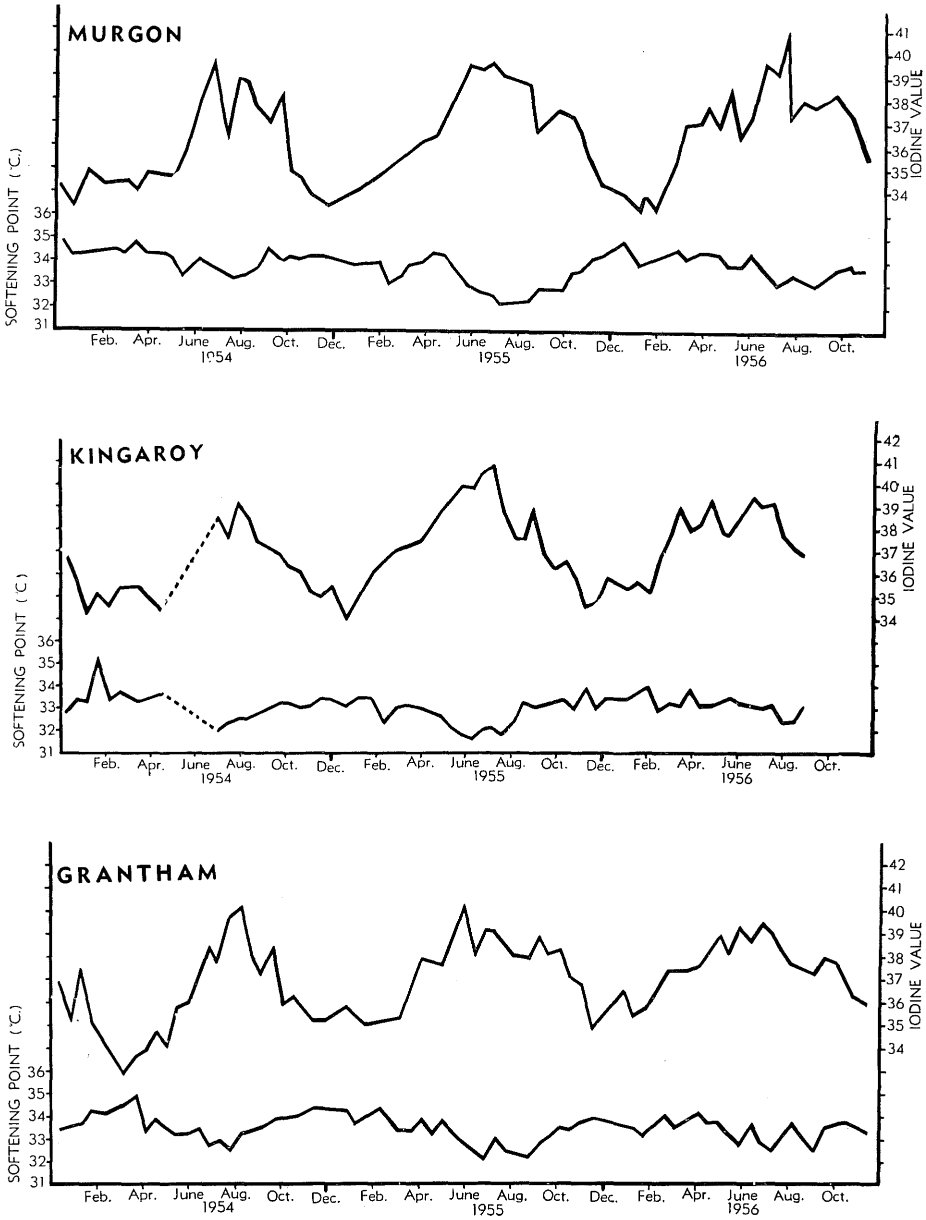

Fig. 2.

Softening Points and Iodine Values for Butterfats from Murgon, Kingaroy and Grantham.

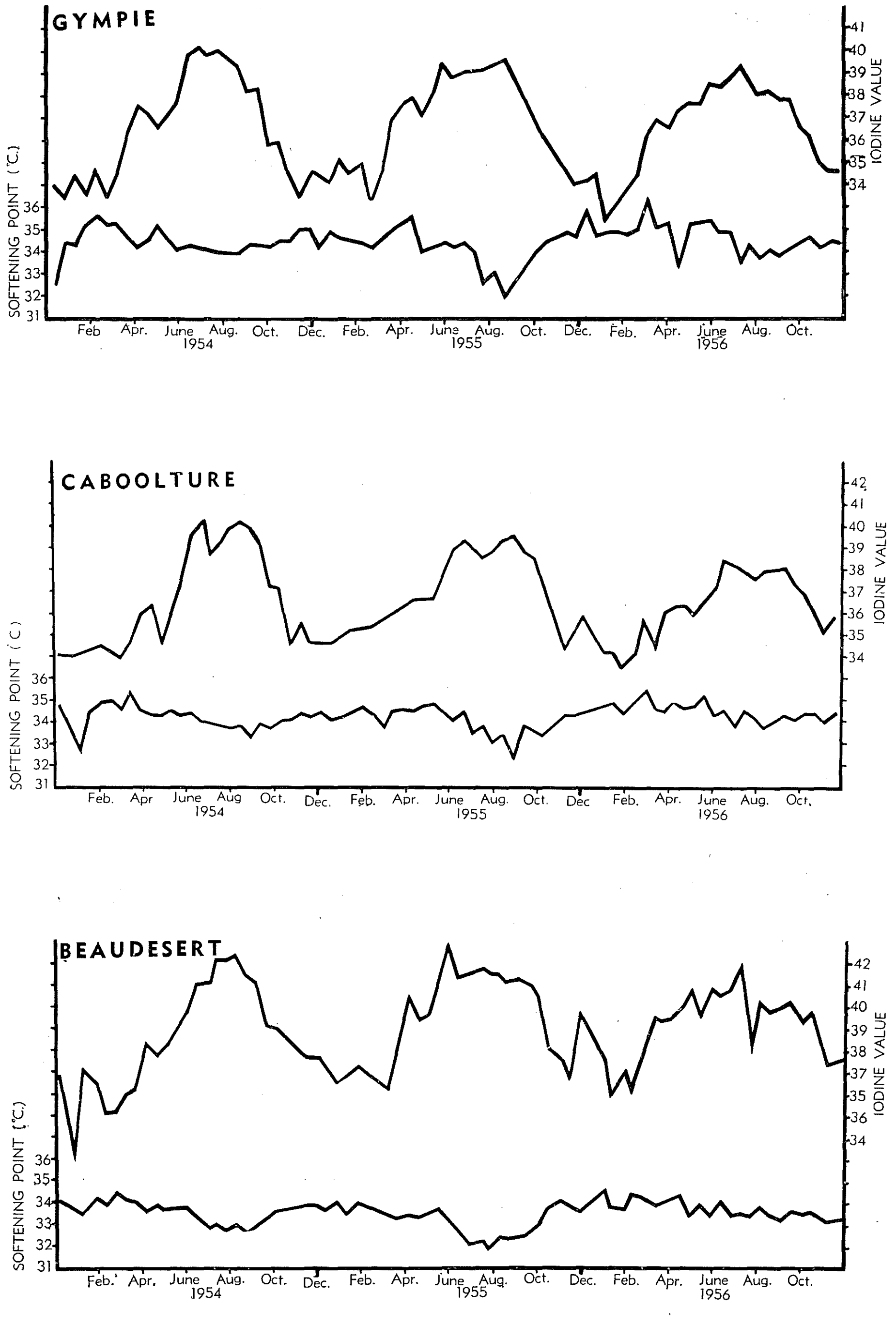

Fig. 3.

Softening Points and Iodine Values for Butterfats from Gympie, Caboolture and Beaudesert.

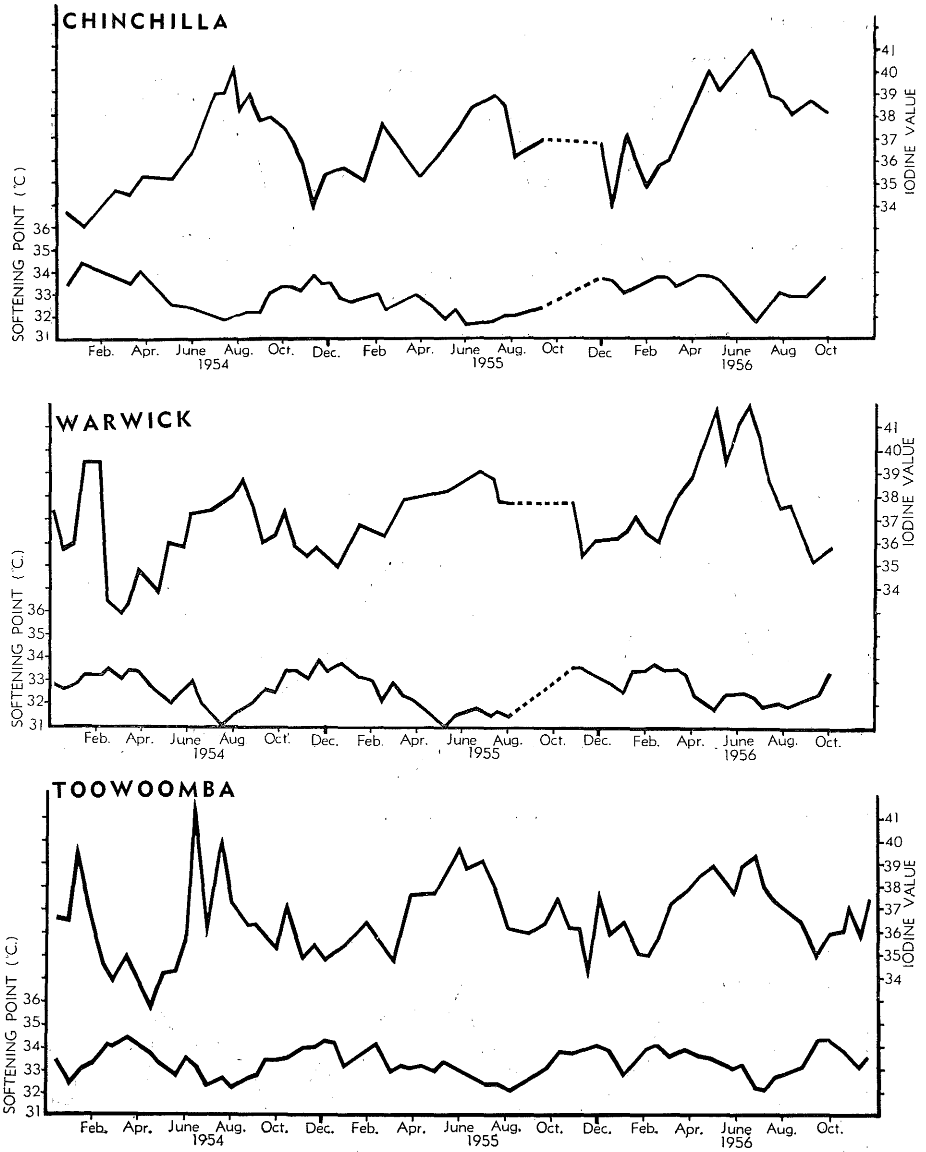

Fig. 4.

Softening Points and Iodine Values for Butterfats from Chinchilla, Warwick and Toowoomba.

(b) All Centres.

Average monthly iodine values of butterfats from all centres are presented in Fig. 5. These results showed a similar yearly seasonal variation, with minimum values occurring in the January–March period and maximum values in the July–August period.

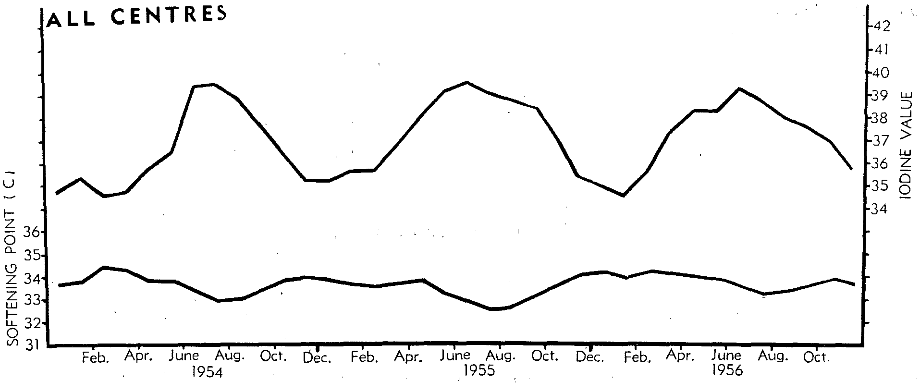

Fig. 5.

Average Softening Points and Iodine Values for Butterfats from All Centres.

(2) Softening Point.

(a) Individual Centres.

Average results and range of softening points of samples from individual centres for the three annual periods are listed in Table 2 and Figs. 1–4. Marked seasonal variations were evident, with minimum values occurring in winter months and maximum values in summer months.

Table 2.

AVERAGE SOFTENING POINTS (°C.) AND RANGE OF VALUES OF BUTTERFATS FROM INDIVIDUAL CENTRES.

District.	Centre.	Year. 1954. Av.	1954. Range.	1955. Av.	1955. Range.	1956. Av.	1956. Range.
Atherton Tableland ..	Malanda ..	34·0	32·7–35·9	*	32·8–35·1	33·6	32·4–34·3
Port Curtis	Gladstone..	35·0	33·7–35·7	34·2	32·9–35·4	34·4	32·8–35·9
Burnett–West Moreton	Biggenden	*	33·3–35·4	34·2	32·9–35·2	*	33·8–35·9
	Murgon ..	34·1	33·3–34·9	33·5	32·3–34·4	33·9	33·1–34·9
	Kingaroy ..	33·2	32·0–35·1	32·7	31·8–33·4	33·2	32·3–33·8
	Grantham	33·6	32·5–34·8	33·3	32·3–34·2	33·4	32·5–34·1
Wide Bay-East Moreton	Gympie ..	34·5	32·5–35·7	34·2	32·0–35·4	34·6	33·4–36·4
	Caboolture	34·2	32·7–35·0	34·0	32·4–34·8	34·5	33·7–35·4
	Beaudesert	33·6	32·6–34·5	33·2	31·9–34·1	33·7	33·1–34·6
Darling Downs ..	Chinchilla..	33·0	31·8–34·4	32·5	31·7–33·5	33·3	31·9–33·9
	Toowoomba	33·3	32·2–34·4	33·2	32·0–34·1	33·3	32·1–34·2
	Warwick ..	32·7	31·1–33·9	32·4	31·0–33·7	32·7	31·8–33·4
All Centres	—	33·8	31·1–35·9	33·4	31·0–35·2	33·8	31·8–36·4

* Results for Malanda (1955) and Biggenden (1954 and 1956) are incomplete.

(b) All Centres.

Average monthly values of softening point of butterfat from all centres are presented in Fig. 5. These results showed a similar seasonal variation for each year, with minimum values occurring in the August–September period and maximum values in the December–May period.

(3) Breed Groupings.

As breed of animal can influence the chemical composition of butterfat, results from individual centres were grouped according to the predominant breed. Breed groupings used were "predominantly Jersey" (> 70 per cent. Jersey), "mixed breeds", and "predominantly A.I.S." (> 70 per cent. Australia Illawarra Shorthorn). The results are listed in Table 2.

Table 3.

AVERAGE IODINE VALUES AND SOFTENING POINTS (°C.) OF BUTTERFAT FROM CENTRES GROUPED ACCORDING TO BREED.

Breed.	Percentage Distribution.			Centre.	Iodine Value.			Softening Point.		
	Jersey.	Mixed.	A.I.S.		1954.	1955.	1956.	1954.	1955.	1956.
Jersey ..	90	10	—	Gladstone ..	35·1	37·8	36·6	35·0	34·2	34·4
	85	—	15	Caboolture ..	36·8	37·4	36·3	34·2	34·0	34·5
	70	10	20	Gympie ..	36·5	36·7	36·5	34·5	34·2	34·6
Mixed ..	40	20	40	Biggenden ..	*	37·6	*	*	34·2	*
	40	—	60	Murgon ..	35·8	37·1	36·8	34·1	33·5	33·9
	50	—	50	Kingaroy ..	36·2	37·4	37·6	33·2	32·7	33·2
	40	—	60	Grantham ..	36·2	37·0	37·5	33·6	33·3	33·4
	40	2	58	Toowoomba..	36·0	36·8	36·8	33·3	33·2	33·3
	47	3	50	Beaudesert ..	38·4	39·6	39·0	33·6	33·2	33·7
A.I.S. ..	25	—	75	Chinchilla ..	36·3	36·9	37·9	33·0	32·5	33·3
	25	—	75	Warwick ..	36·6	37·2	38·2	32·7	32·4	32·7
	35	—	65	Malanda ..	38·4	*	38·2	34·0	*	33·6

* Results for Malanda (1955) and Biggenden (1954 and 1956) are incomplete.

With mixed breeds, iodine values of samples from the Wide Bay–East Moreton district represented by the Beaudesert centre were high in 1954 and 1955.

With A.I.S. breeds, iodine values of samples from the Atherton Tableland district represented by the Malanda centre were high in 1954.

As with iodine values, results from centres were grouped according to the predominant breed (Table 3).

With A.I.S. breeds, softening points of samples from the Atherton Tableland district, represented by the Malanda centre, were high in 1954.

(4) Relationships.

Iodine values and softening points were examined statistically for the three annual periods. In addition, the relationship of iodine values to total vitamin A potency of butterfats (Gartner 1959) was examined. The results are presented in Table 4.

Table 4.

CORRELATION COEFFICIENTS BETWEEN IODINE VALUE AND SOFTENING POINT (°C.) AND IODINE VALUE AND TOTAL VITAMIN A POTENCY OF BUTTERFATS.

Year.	Iodine Value and Softening Point.	Iodine Value and Total Vitamin A Potency.
1954	−0·91**	+0·98**
1955	−0·79**	+0·94**
1956	−0·64*	No vitamin A analyses

** Significant at 1% level.
* Significant at 5% level.

(5) Condition of Feed.

The main characteristics of feeding conditions within districts are given above. Climatic variations between seasons in individual centres, however, resulted in varying qualities of feed during this survey. Where marked, these variations are described in general terms. Pasture and crops were considered to be of good quality if they were still producing leaf and had not matured to the seeding stage.

Initial sampling of butter was commenced at the conclusion of semi-drought conditions in all centres during the late spring/early summer period of 1953. These conditions were relieved by good general rains during January–April in 1954. Feed conditions during 1955 and 1956 were regarded as normal. The variation in climatic conditions in 1954 resulted in pastures maturing and seeding during April–May, compared with the normal March–April period in 1955 and 1956. Towards the end of 1956 semi-drought conditions became manifest.

Marked variations in the condition of feed in different years at various centres were noted as follows:—

In Gladstone in 1955 pasture quality during summer was of a lower standard than during 1954 and 1956.

In Murgon the quality of pasture in summer-autumn differed between 1954 and 1955–56. In 1954, pastures matured and seeded in May, in contrast to the early maturing from January onwards in 1955 and February onwards in 1956.

In Grantham a late summer/autumn flush growth in 1954 contrasted with the summer-maturing pattern of 1955 and 1956.

The late arrival of summer rains on the Darling Downs in 1954 was reflected in good quality feed being available in the Toowoomba and Warwick areas through into the winter months, in contrast with the normal period of November–January. General all-the-year grazing of crops was evident in the Darling Downs district, in contrast with other districts.

(6) Stage of Lactation.

Herd recording information on cows tested in each centre during 1948–1955 was analysed to determine the percentage of cows calving each month. Records of 66,702 lactations from all centres were examined. The results are listed in Table 5.

Table 5.

PERCENTAGE OF COWS CALVING IN ANY ONE MONTH.

Centre.	Jan.	Feb.	Mar.	Apr.	May.	June.	July.	Aug.	Sept.	Oct.	Nov.	Dec.
Malanda	7·5	7·1	6·8	7·2	6·8	8·0	8·7	9·5	9·3	10·7	9·7	8·8
Gladstone	5·5	2·9	2·2	2·3	3·9	6·1	7·2	15·6	15·1	17·3	14·1	7·8
Biggenden	10·5	5·0	5·1	4·0	5·9	6·0	6·5	9·0	10·9	12·4	14·1	10·6
Murgon	8·2	6·2	5·3	5·4	6·3	8·5	8·8	10·1	10·3	10·5	11·0	9·4
Kingaroy	7·9	6·2	6·4	5·7	5·6	6·1	7·9	10·3	11·5	12·7	10·4	9·3
Grantham	5·4	3·9	4·6	5·1	5·7	7·1	11·5	8·7	7·3	14·5	16·6	9·6
Gympie	7·5	5·3	5·2	4·5	4·9	4·7	6·9	11·2	13·1	13·9	12·4	10·4
Caboolture	8·6	6·3	5·6	5·1	5·3	7·2	9·8	10·9	10·7	11·0	10·8	8·7
Beaudesert	8·0	6·7	7·3	6·9	7·1	7·4	7·2	9·4	9·0	11·1	10·7	9·2
Chinchilla	8·3	6·2	5·6	5·2	5·2	6·7	7·7	10·3	10·6	12·9	11·2	10·1
Toowoomba ..	10·1	6·6	7·2	5·6	5·3	6·6	7·9	10·8	10·6	10·4	9·7	9·2
Warwick	7·1	5·7	5·8	5·0	6·1	7·0	10·0	9·5	12·1	11·7	11·1	8·9
All Centres Average	7·9	5·7	5·6	5·2	5·7	6·8	8·3	10·4	10·9	12·4	11·8	9·3

Herds from the Gladstone area exhibited a marked seasonal calving pattern. The most uniform calving pattern was evident in the Malanda and Beaudesert centres.

(7) Cream Churning Temperatures.

The temperatures of cream at churning of butters sampled were averaged for each quarter over the 3-year period and the averages are listed in Table 6. Temperatures tended to be slightly higher in the January–March period and relatively constant for the remaining nine months. Only one centre, Gladstone, evidenced any wide variation between quarters. This centre also exhibited the highest temperatures.

Table 6.

AVERAGE CREAM CHURNING TEMPERATURES (°F.) OF BUTTER SAMPLES FOR 1954–1956 CALCULATED QUARTERLY.

Centre.	January–March.	April–June.	July–September.	October–December.
Malanda	47	46	45	46
Gladstone	54	55	52	53
Biggenden	46	47	47	47
Murgon	49	49	48	48
Kingaroy	51	49	49	51
Grantham	48	47	46	48
Gympie	46	46	46	46
Caboolture	47	48	47	47
Beaudesert ..	46	47	47	47
Chinchilla	46	47	46	46
Toowoomba ..	45	45	45	44
Warwick	46	46	45	46
Average	47·7 (42–58)*	47·3 (42–56)*	47·0 (38–56)*	47·2 (40–58)*

* Values in brackets represent the extremes for all centres.

There was an extremely wide range of individual churning temperatures within quarters.

V. DISCUSSION.

(1) General.

There was a uniform seasonal variation in iodine values and softening points of the butterfats. The monthly average iodine values and softening points from all centres showed similar seasonal variations in the three years examined. The variations in these values for individual centres was less uniform.

The values obtained in this survey were in agreement with those found by Wiley and Loftus-Hills (1949) in their examination of Australian butterfats. Values were of a comparable nature to the constants of New Zealand butterfats reported by Cox and McDowall (1948), McDowell (1953), Mayhead and Barnicoat (1956) and McGillivray (1956), although Queensland values covered a slightly wider range. Both Australia and New Zealand, in contrast with dairying countries in the northern hemisphere, rely on continuous grazing for milch animals without recourse to stall feeding during winter months. It might be expected, therefore, that seasonal variations in values for constants in butterfat would be similar in Australia and New Zealand.

A relationship between iodine value and softening point, significant at the 1 per cent. level, was obtained in two of the three years. Such a relationship was explained by Hilditch (1940) in terms of the oleic acid content of butterfat. McDowall (1953), however, suggested that differences in the combination of fatty acids to form the glycerides can compensate for the tendency of oleic acid glycerides to be oily in nature.

(2) Influence of Condition of Feed on Iodine Values.

The relationship of oleic acid content of butterfat to iodine value has been reported by several workers. Hilditch (1940) reported that variations in the iodine values of milk fats were due to changes in the oleic acid content. Hansen and Shorland (1952) concluded that, although the iodine value of butterfat was not directly proportional to the C18 unsaturated acids of fat, it was an indication of the amount of these acids. McDowell (1953) and Wood and Haab (1957) analysed samples of butterfat by spectrophotometric methods and demonstrated the direct relationship of oleic acid content to iodine value.

The effect of chemical composition of feed on the unsaturation of fatty acids of butterfat has been established. Glascock (1954) indicated that oleic acid is not synthesised to any appreciable extent in the udder but is derived directly from the diet. This conclusion was supported by Mayhead and Barnicoat (1956). Shorland (1944) reported a high proportion of oleic acid in the fat from pastures. He found that the fat content of pastures was characterised by a high content of C16–18 unsaturated acids (82·9 per cent.), of which oleic acid was predominant (76·5 per cent.). Worker and McGillivray (1957) showed that the botanical composition of pasture influenced the unsaturated fatty acid content of the diet. They reported that milk fat from clover-fed cows had a lower iodine value than that from cows fed on ryegrass.

McGillivray (1952) advanced the theory that a second factor, the tocopherol content of the pasture, is associated with the seasonal variation of unsaturation of fatty acids in butterfat.

No differential unsaturated fatty acid analyses have been reported for Queensland pastures. However, it seems valid to assume that a similar dietary contribution from pastures exists in Queensland.

As the breed and lactation pattern of milch animals within centres does not alter materially within a short term, variations of the condition of feed between years should be reflected in the iodine value of fats. Variations of this nature were found in this survey.

In Gladstone, minimum iodine values which occurred during January–March were at their highest level in 1955. The quantity and the quality of feed during this year were both of a lower standard than in 1954 and 1956. In Murgon, low iodine values continued from January until June in 1954, in contrast with the minimum period of November–February in 1955 and January–March in 1956. Good quality pasture was available until winter in 1954 in contrast with the more normal pattern of summer maturing of pastures in 1955 and 1956. Minimum iodine values from Grantham in 1954 coincided with the autumn flush pasture growth and were of a lower degree than minimum values in 1955 and 1956. A similar variation occurred in 1954 in samples from Warwick and Toowoomba. Seasonal trends were less uniform in the Darling Downs district than in other centres. The comparatively extensive use of grazing crops such as oats, Sudan grass and wheat in this district could explain these variations.

Possible explanations of the differences in values between consecutive samples from certain centres (Toowoomba, Warwick, Gympie) are (1) the variation in condition of feed resulting from local weather conditions, and (2) the influence of these weather variations on the metabolism of the animal. McGillivray (1956) found evidence of weather variations causing fluctuations of 1-2 units in iodine values between consecutive samples. Mayhead and Barnicoat (1956) also reported daily variations in iodine values of samples from the small herd in their investigations.

Iodine values generally remained at a low level until the April–May period in 1954, in contrast with the February–March period in 1955 and 1956. This possibly resulted from better quality feed being available through to the late summer months in 1954.

The variations within centres between seasons in different years in this survey indicated the influence of the condition of feed on the degree of unsaturation of fatty acids in butterfat.

(3) Influence of Stage of Lactation on Iodine Value.

Schlag (1926) reported a fall in iodine values of butterfat during the first three months of lactation, followed by a steady rise for the remaining seven months. McDowall (1953) reported that other European workers confirmed this influence of lactation on iodine value.

Maximum average annual values and the widest ranges of iodine values were found in samples from the Malanda and Beaudesert centres (Table 1). It was in these centres that the percentage of cows calving monthly was most uniform (Table 5). This indicated that the proportion of cows "in milk" over three months was greatest in these centres and also that there was a more uniform distribution of varying stages of lactation among herds.

A comparison of the influence of breed on iodine values (Table 3) for the six centres comprising mixed breeds showed the Beaudesert centre to have higher than average values in all three years.

The seasonal nature of calving was most marked for Gladstone. In the August–November period 62·1 per cent. of cows calved, in contrast with the all-centres average of 45·5 per cent. Samples from this centre exhibited extreme seasonal fluctuations in iodine values.

These results suggest that the influence of stage of lactation on iodine value is strong. However, because of the interaction of feed, breed and stage of lactation, no specific conclusions on this point can be drawn.

(4) Relationship of Iodine Value and Total Vitamin A Potency.

McGillivray (1956) reported a correlation of +0·459 between iodine value and total vitamin A potency of butterfat. McDowell and McDowall (1953) showed that in New Zealand commercial butterfats a parallel between vitamin A potencies and iodine values exists. In Queensland a correlation of a high order—viz., +0·98 in 1954 and +0·94 in 1955, both significant at the 1 per cent. level—was obtained.

(5) Cream Churning Temperatures and Butter Defects.

The relationship of iodine values and softening points of butterfat to body and texture of butter has been examined extensively and references were reported by McDowall (1953). While the rate and degree of cooling, time of holding of cream and the temperature and technique of butter washing all determine the body and texture of butter, temperature of cream at churning is a reliable guide in relating manufacturing conditions to the varying chemical composition of butterfat. The churning temperature records obtained in this survey indicate only minor variations from average churning temperatures during the year. This absence of control was reported by Wiley and Loftus-Hills (1949). The average cream temperature range of 47·7 to 47·0 deg. F. among quarters was extremely narrow when related to recommended levels for Queensland conditions of 42–46 deg. F. during summer months and 46–50 deg. F. during winter months. The wide range of individual churning temperatures, 38 to 58 deg. F., during the year indicated unsatisfactory control of temperature.

Mottle defects are evident in Queensland butters during the spring–summer period. These occur because the degree of working during manufacture is insufficient to incorporate evenly the salt and moisture constituents. As the normal practice is to work butter until it is soft, the conclusion to be drawn is that with butter in which this defect occurs grains were not in the correct physical state to permit optimum working conditions. Several

European workers have established a relationship between iodine values and texture faults. Dolby (1949) drew attention to the relationship between iodine value and the hardness of butter. The absence of seasonal variations in cream churning temperatures of butters examined in this survey suggest that due recognition had not been accorded to variations in iodine values of butterfat.

The texture faults "open-ravelly" occur in Queensland butters during the April–June period. Butterfat during this period was characterised by a rapid rise in iodine values, while softening points exhibited only a slight decrease. Corrective manufacturing methods in this instance should be directed to alterations in the rate and degree of cooling rather than in the cream churning temperatures. Information on cooling techniques was not available. References to similar circumstances in New Zealand butterfats were reported by McDowall (1953).

From information obtained in this survey it is concluded that a more correct application of cream churning temperatures in relation to variations in the iodine values of butterfats would assist in minimising the incidence of body and texture defects.

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REFERENCES.

BARNICOAT, C. R. 1944. The softening-point of fats. Analyst 69: 176-178.

BOLTON, E. R. 1928. Oils, Fats and Fatty Food. 2nd ed. J. & A. Churchill, London.

COX, C. A., and MCDOWALL, F. H. 1948. Iodine, Reichert and saponification values and softening points of monthly samples of butterfats from nine commercial factories over four years. J. Dairy Res. 15: 377-386.

DOLBY, R. M. 1949. The relation of hardness of New Zealand commercial butter to composition of the butterfat. J. Dairy Res. 16: 336-347.

GARTNER, R. J. W. 1959. Variations in the carotene and vitamin A contents of Queensland butterfats. Qd J. Agric. Sci. 16: 1-30.

GLASCOCK, R. F. 1954. Some recent applications of isotopes to research into the biochemistry of the mammary gland. Dairy Sci. Abstr. 16: 859-872.

HANSEN, R. P., and SHORLAND, F. B. 1952. Seasonal variations in the fatty acid composition of New Zealand butterfats. Biochem. J. 52: 207-216.

HILDITCH, T. P. 1940. Chemical Constitution of Natural Fats. Chapman and Hall Ltd., London.

MAYHEAD, J. W., and BARNICOAT, C. R. 1956. Variations in iodine value of milk fats. J. Dairy Res. 23: 238-247.

MCDOWELL, A. K. R. 1953. Seasonal variations in the nature of the unsaturated acids of butterfat as estimated by spectrophotometric methods. J. Dairy Res. 20: 76-100.

MCDOWELL, A. K. R., and MCDOWALL, F. H. 1953. The vitamin A potency of New Zealand butter. J. Dairy Res. 20: 76-100.

MCDOWALL, F. H. 1953. The Buttermaker's Manual. New Zealand University Press, Wellington.

MCGILLIVRAY, W. A. 1952. The effect of tocopherol and carotene supplements on the vitamin A potency of New Zealand butterfat. J. Dairy Res. 19: 119-126.

MCGILLIVRAY, W. A. 1956. The vitamin content of New Zealand butterfat. N. Z. J. Sci. Tech. A38: 466-472.

RICE, E. B. 1956. Report of the Director of Dairying. *In* Rep. Qd Dep. Agric. 1955-56.

SCHLAG, H. 1926. Molkereiztg, Hildes 58: 2. (Quoted by McDowall, F. H., 1953).

SHORLAND, F. B. 1944. Leaf lipids of forage grasses and clovers. Nature 153: 168.

WILEY, W. J. and LOFTUS-HILLS, G. 1949. Survey of properties, production and manufacture of Australian butters. Technical Sub-Committee on Dairy Products of the Australian Committee on Animal Production.

WOOD, F. W., and HAAB, W. 1957. Seasonal and regional variations in the unsaturated acids of Alberta butterfat. Canad. J. Anim. Sci. 37: 1-7.

WORKER, N. A., and MCGILLIVRAY, W. A. 1957. The influence of botanical composition of the pasture on the vitamin content of milk fat. J. Dairy Sci. 24: 85-94.