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Assessment of cyclopropenoic acid levels in commercially available Australian whole cottonseeds and cottonseed meals

Executive Summary

Carcases having hard fat at boning temperatures are a significant problem for the Australian beef industry and attempts to minimise the problem by modifying temperature cycles can have an adverse effect on meat quality. Feeding of whole cottonseed to cattle has been implicated in contributing to increased fat hardness through the presence of cyclopropenoic fatty acids (CPFA) present in the oil.

It was the aim of this study to determine the CPFA contents of the major varieties of cottonseeds used for cotton production in Australia and to determine if differences occurred between varieties. These values were compared with published values for whole cottonseeds from other countries.

Twenty-five varieties of commercial Australian cottonseeds were analysed for their oil contents, fatty acid compositions and for their CPFA contents. Whole cottonseeds were obtained from four locations ranging from central NSW to central Queensland and some varieties were obtained from two seasons.

The total oil content of linted whole cottonseed did not significantly differ between varieties and accounted for about 21% of the weight. Seeds of unknown origins obtained from feedlots were highly variable in oil contents and had a mean value of about 17%. The oil content of cottonseed meal, a crushed de-fatted product, was about 3%.

The fatty acid composition of the extracted oils was remarkably constant across varieties, locations and seasons (yields from 2 years). The major fatty acids present in cottonseed oils were linoleic acid (56.7 ± 1.61%), palmitic acid (23.0 ± 1.09%), oleic acid (15.0 ± 1.11%) and stearic acid (2.29 ± 0.11%) and these values are fairly similar to those previously reported for different varieties. The fatty acid compositions of the varieties containing the INGARD® gene were not significantly different from the standard varieties.

The content of total CPFA was generally below 0.8% of the total fatty acids with malvalic acid being the major CPFA (0.38%) followed by sterculic acid (0.19%). Overall, values for all varieties were fairly constant ranging from means of 0.38 to 0.75% but most falling between 0.5-0.6% of the total fatty acids. The lowest value for CPFA was obtained with the variety Pima S-7. On the other hand, individual values of CPFA for some varieties approached 0.8% (variety CS8S) with malvalic acid being 0.5%. INGARD® varieties were not different from the standard. Analysis of single varieties grown in several locations, some from two seasons, did not show any significant variation. The *off-grade* varieties of seeds appeared to have a significantly higher content of CPFA compared with those *product-grade* varieties obtained at the same time.

Thus, given several exceptions, it would appear that the content of CPFA in extracted oils from most varieties of cottonseeds is quite similar. Furthermore, their contents are similar to and not higher than those reported for the US and other countries.

On the basis of these findings, there would appear to be little advantage in selecting particular varieties of cottonseeds for use as feeds for feedlot cattle. Whilst Pima S-7 does have somewhat lower CPFA contents, its use as a feed ingredient would be limited as it is not widely available.

The requirement for evaluation of a field method for assessing the CPFA contents in oils of whole cottonseed and meals was not necessary in view of the outcome of this study. However, a literature search was undertaken to find, or develop, a rapid, safe and easy to use field method. All methods found and reported here were unsuitable for this purpose because of their complexity, equipment needs or requiring use of hazardous chemicals.

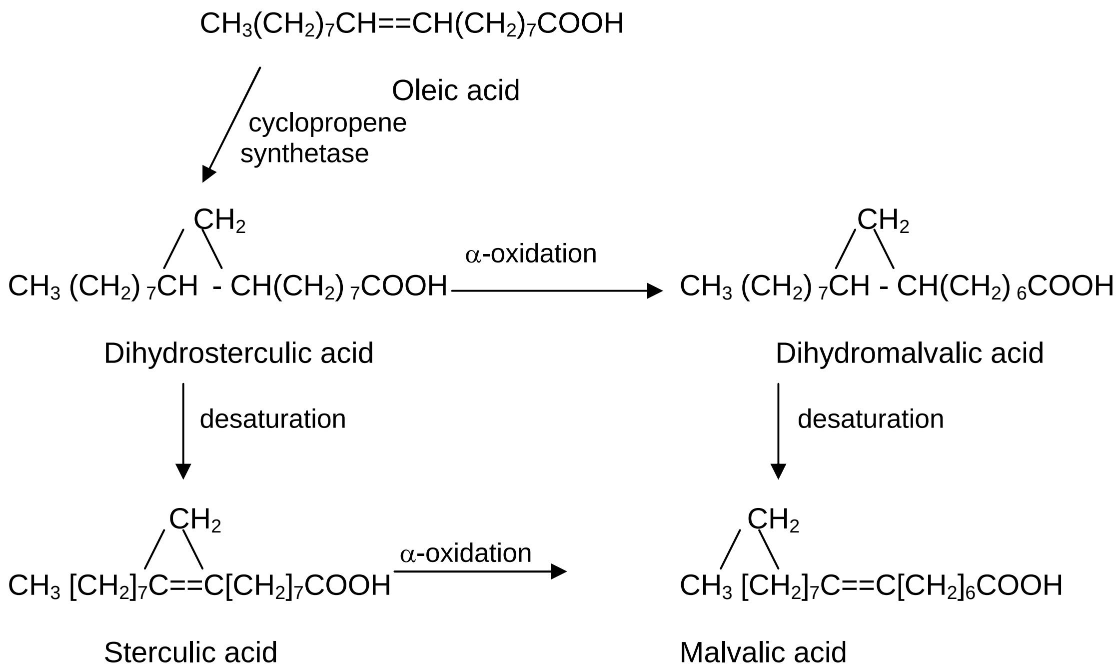
Introduction

Whole cottonseed has been identified as an energy dense feedstuff that has potential for greater utilisation in the Australian beef feedlot industry. Current limited useage of whole cottonseed is in many cases attributed to the presence of high levels of cyclopropenoic fatty acids and its affect on fat quality (hardness) in carcases.

Contents

1 Background

Cottonseed oils contain small amounts of cyclopropenoic fatty acids (CPFA) such as sterculic and malvalic acids. These CPFA are present, along with other fatty acids, as triacylglycerols and have been reported to range in amounts from about 0.6 to 1.5% of the total fatty acid content (Pandley and Suri, 1982). Sterulic and malvalic acids are derived from oleic acid as indicated in the pathway below (from Gurr and Harwood, 1991).



CPFAs are not evenly distributed throughout cottonseeds but are located mainly in the axis (42%) and root tip (34%) which accounts for only 4% and 1% of the seed weight respectively (Fisher and Cherry, 1983). Wood (1986) found that oil from the hypocotyl end of the seed contained 3.4% CPFA compared with only 0.4% from the chalazal end of the TX CABCS-X variety.

Different varieties of cottonseeds have been found to vary in their contents of CPFA. Pandey and Suri (1982) used a HBr titration method to determine malvalic acid (total CPFA) in the crude oil of 30 varieties of cottonseeds belonging to 4 different cultivated botanical species. Varieties of *Gossypium barbadense* L. had CPFA contents of 0.67%, *Gossypium hirsutum* L., 0.69-1.02%, *Gossypium herbaceum* L., 1.05-1.19% and *Gossypium arboreum* L., 1.17-1.51%. In other studies the CPFA content of 7 cottonseed hybrids also grown in India, ranged from 0.6 to 1.1% (Badami et al, 1977). It is possible that some of the variation in oil content may result from different proportions of tissues in the seed components.

Lawhon et al, (1976) reported on the CPFA contents of oils from sixteen new and experimental varieties of glandless and glanded cottonseed developed in the US. The glandless seed varieties ranged from 0.06- 0.31 (mean value 0.23%) and the glanded varieties from 0.07-0.28% (mean value 0.23%).

Early methods for detection of the presence of CPFA in oils were a positive Halphen test (AOAC 1998) or HBr titration (Pandey and Suri, 1982). Gas-liquid chromatography has proved to be quite a satisfactory method that allows identification and quantification of the individual CPFAs (Vickery, 1980). However there are reports that cyclopropene fatty acid esters undergo partial thermal degradation during GLC on some types of columns (Fisher and Schuller, 1981). For this reason and also due to the lack of a complete separation of the CPFA from other esters under the conditions then being used, Wood (1986a) developed an HPLC technique for the separation of phenacyl derivatives of the fatty acids. For the work reported here, we have used GLC with capillary columns with silicone liquid phases which have previously been shown to be quite suitable and do not result in degradation or rearrangement of the CPFA. Furthermore, we have obtained excellent resolution of the CPFA from the other fatty acids. Also, the percentages of CPFA found in the various cottonseed oils was of a similar order to that reported by Wood (1986a) using the HPLC method.

2 Project Aim

To determine if a variation exists in the content of cyclopropenoic acids in oils from Australian commercial varieties of whole cottonseeds and cottonseed meals so that those varieties having lower amounts can be identified and selected for the feedlot industry.

2.1 Project Objectives

1. Evaluate analytical methods for assessing the cyclopropenoic acid (CPFA) contents in oils of the major commercial varieties of whole cottonseed and cottonseed meals. Cost and potential for commercial application will be considered in this evaluation.
2. To determine the contents of CPFA in the oils of the major commercially available varieties of whole cottonseed.
3. To determine the residual amount of CPFA in de-fatted cottonseed meals.
4. Identify commercial varieties of whole cottonseed, if they are available, that have low levels of CPFA, so that they can be sourced as a feed ingredient for beef cattle rations.
5. Make recommendations regarding the suitability of commercially available varieties of whole cottonseed and cottonseed meal for inclusion in rations for the beef feedlot industry, including the implications of the research results on inclusion rates. Collaboration with industry consultants, if required, will be facilitated by MLA.

3 Method

Sample collection

Whole cottonseeds were obtained from the following companies (see Table 1):

Cotton Seed Distributors Ltd, Wee Waa, NSW (CSD).
Samples were obtained from the silos during December 1998 and June 1999. Seven samples of Sicala V-2, both linted and delinted, were collected in such a way that, almost certainly, they would have originated from different farms.
Deltapine Australia Pty Ltd, Narromine, NSW
Samples were obtained from the silos during December 1998. Five replicates of 5 varieties of linted and delinted seeds were collected in such a way that, almost certainly, they would have originated from different farms.
Queensland Cotton, Moura, Central Qld
Fifteen varieties of cottonseeds (linted) were collected during June 1999.
Queensland Cotton, Dalby, Southern Qld,
Fifteen varieties of cottonseeds (linted) were obtained during June 1999.

Whole cottonseed was also obtained from feed storage bins at 12 feedlots in NSW and Queensland during February 1999. The variety and origin of the seed is unknown.

Cottonseed meal was obtained from the following suppliers in April 1999:

Cargill Oilseeds Australia, Brisbane	(Supplier 1)
Brisbane Export Corporation Pty Ltd. Brisbane	(Supplier 2)
Inghams Enterprises Pty Ltd, Brisbane	(Supplier 3)
Ridley AgriProducts Pty Ltd, Brisbane	(Supplier 4)
Riverina Stock Feeds, Meadowbrook, Qld	(Supplier 5)
Virginia Produce, Brisbane	(Supplier 6)

Extraction of oils from cottonseeds and cottonseed meals

Approximately 1 g (10-12 seeds) of whole cottonseeds, either linted or de-linted, were cracked with a hammer and weighed exactly. Lipid was extracted by homogenising the seeds in 20 mL of chloroform:methanol 2:1, v:v and allowing to stand overnight. The extract was filtered through a Whatman No. 1 filter paper and the filtrate was washed with one-fifth volume of 0.73% NaCl solution. Following the phase separation, the lower phase containing the lipid, including CPFA, was removed and made up to 20 mL with chloroform:methanol 2:1 v:v. Ten mL of the lipid extract was transferred to a tared vial and the solvent removed under a stream of nitrogen. The dried vial was re-weighed and the amount of oil in 10 mL of extract was determined. From this figure, the % oil content of the seeds was determined. An aliquot of the remaining 10 mL was dried under nitrogen and used for fatty acid analysis following methyl esterification. All extractions were performed in duplicate.

The same procedure was used for cottonseed meal except that 2g was used and the volume of solvent was doubled.

Evaluation of analytical methods for assessing CPFA contents in cottonseed oils

An objective of this work was to evaluate known methods of CPFA determination for their suitability for rapid analysis of cottonseed oils in a commercial environment. Such a procedure would be invaluable for identifying CPFA contents in whole cottonseeds so that a decision for their end use could be made. Naturally, this would be dependent upon finding significant differences between seeds.

Unfortunately, none of the known methods are suitable for field analysis as they all require laboratory equipment or chemicals that are unsuitable for handling outside a laboratory.

Halphen method
The Halphen test involves heating a small amount of cottonseed oil in a mixture of butanol and 1% carbon disulphide in a closed tube in the presence of light and then measuring the pink *Halphen* pigments spectrophotometrically (AOAC 1998a,b). The method is quantitative and the amount of CPFA can be determined from a standard curve. The method does however measure the hydrogenated CPFAs such as dihydrosterculic and dihydromalvalic acids (Vickery, 1981) and so will give a higher value for total CPFA. Whilst this method can be relatively easily carried out in a laboratory it does contain dangerous chemicals and could not be modified for field use.

GLC method
The separation of methyl esters of CPFA by GLC has been used for many for many years (Vickery, 1980) although in some systems there can be some decomposition of sterculic and malvalic acids at high temperatures. Successful results have been obtained with the use of columns containing silicone liquid phases of the type used in the present work (see Christie, 1989). Furthermore, it is important that acidic conditions be avoided and for this reason, alkaline conditions were used for methyl ester formation. This method is not suitable for the rapid analysis of oils for the content of CPFAs.

HPLC method
Prior to running samples on HPLC it is necessary that the fatty acids (including the CPFA) be derivatised with a compound such as α-bromoacetophenone to form phenacyl derivatives so that compounds can be detected in the UV-visible range following elution from the column. HPLC is performed using octadecyl columns with an acetonitrile-water solvent system (Wood, 1986a). This method is not suitable for the rapid analysis of oils for the content of CPFAs.

The following describes the actual procedures used for the present study.

Determination of CPFA

Individual CPFA in the extracted oils were identified and quantified (as a percentage of total fatty acids) by gas-liquid chromatography (GLC) of their methyl esters.

Methyl esters of fatty acids were prepared using sodium methoxide essentially as described by Bannon et al (1982). The fatty acid methyl ester composition, including CPFA, was determined on all samples by GLC (Shimadzu GC17 with AOC17 auto-injector) using a 50mx0.25mm glass capillary column (CP-Sil-88, ChromPak, Holland) with nitrogen as carrier gas. The initial temperature was set at 150°C, incrementing at 5°C min^{-1} to 235°C and held at that temperature for 8 min. Fatty acids were identified by comparison of retention times with standards (Alltech). Shimadzu Class 10 software was used for peak area calibration.

CPFA standards

Malvalic acid – Malvalic acid was not available commercially and therefore it was necessary to obtain it from plant material. The oil from the seeds of the Illawarra Flame tree (*Brachychiton acerifolius*) contains significant amounts of this CPFA (about 7%, Vickery, 1983). Lipids were extracted from seeds as described above for the cottonseeds and an aliquot was methylated and run on GLC. Malvalic acid was identified as eluting from the column with a relative retention time of 1.012 compared with C18:0 just ahead of C18:1 with a retention time of 1.042.

Sterculic acid – Similarly sterculic acid was not available commercially and therefore it was necessary to obtain it from plant material. The oil from *Sterculia foetida* seeds contains high amounts of sterculic acid (about 45% of total fatty acids, Roomi and Hopkins, 1970) and therefore such material provides a useful source for identification purposes. Lipids were extracted from seeds as described above for the cottonseeds and an aliquot was methylated and run on GLC. Sterculic acid was identified as eluting from the column having a relative retention time compared with 1.095 to C18:0 just ahead of C18:2 with a retention time of 1.118.

The cyclopropanoic acid dihydrosterculic acid (cis-9,10-methylene-octadecenoic acid, Matreya, Inc. Pleasant Gap, PA, USA) was a gift from Dr Brian Siebert, Department of Animal Science, University of Adelaide.

In this work CPFA refers to malvalic and sterculic acids. Thus total CPFA does not include dihydrosterculic acid. To our knowledge, only the CPFA malvalic and sterculic acids have been reported as inhibitors of Δ^9–desaturase.

Effect of column temperature on stability of CPFAs

The possibility of thermal degradation of CPFAs during GLC was investigated by running extracts from cottonseed, Sterculia foetida seeds and Flame Tree seeds under two different temperature profiles. For the first, the standard gradient temperature profile as described above was used. For the second, the column was maintained at a lower temperature (180°C) for the duration of the run. The percentage distribution of all fatty acids (including the CPFAs) was essentially the same irrespective of the temperature profile used (Table 2). This strongly suggests that no thermal degradation occurred under the column conditions used and therefore the standard method is suitable for the determination of CPFA.

4 Results

Oil contents of whole cottonseeds and cottonseed meals

Oil content of whole cottonseed from seed suppliers

Linted seeds from all origins had mean ± SD oil contents of 20.6 ± 1.88 % (w/w) and delinted seeds 23.0 ± 2.33 % (w/w). These percentages are in agreement with reported values for oil contents (15-24%, Hammond, 1992). The difference in oil content between linted and delinted seeds is greater than would be expected from the weight of lint associated with the seed and may indicate that the extraction from the linted seeds is less efficient.

The oil content of individual varieties from all locations and times is shown in Table 3 for linted and delinted cottonseeds. Detailed results for oil contents are also shown in the tables for each variety from different locations and times (see Tables 8-28).

Oil content of whole cottonseed from feedlots

All samples of whole cottonseeds obtained from feedlots were linted and had an oil contents of 17.0 ± 3.80 % (w/w), somewhat lower than that found for the whole cottonseeds from the seed suppliers (see Table 4).

Oil content of cottonseed meal

Oil content of the cottonseed meal samples was 3.40 ± 0.61 % (w/w), (see Table 5).

Cyclopropenoic fatty acid composition of whole cottonseeds and cottonseed meals

Coefficient of variation in fatty acid and CPFA contents of oil from within cottonseed varieties

The variation occurring within single cottonseed varieties was investigated using seeds obtained from Narromine (December 1998) and from Wee Waa (December 1998). Five samples each of DeltaJewel, DeltaOpal, DeltaPearl and DP5690 and 7 samples of Sicala V-2 were analysed for variation within variety. For the major fatty acids such as palmitic, oleic and linoleic, the coefficient of variation (%CV) between individual samples was less than 3% for both the linted and delinted seeds and was somewhat higher for those fatty acids present in very small amounts (Table 6). For the total CPFA, comprising only 0.4 to 0.6% of the fatty acids in the oil, the %CV was 6-10%. This did not differ significantly between linted and delinted seeds. Of the CPFA present, malvalic acid was the major component, 0.31 to 0.38% with a %CV ranging from 4-10%. This limited data suggests that for these samples, there were only minor variations in the oil composition of individual varieties of cottonseeds.

Composition of oils from individual varieties of whole cottonseeds

Overall, the fatty acid composition of the cottonseed oils was remarkably constant across varieties, locations and seasons (yields from 2 years). Table 7 shows a summary of all analyses performed on 25 varieties of cottonseeds including 5 containing the INGARD® gene. Those varieties containing the heliothis control gene were NuCOTN 37, Sicala V-2i, Siokra V-15i, Sicot 189i and Sicot 50i. The major fatty acids present in cottonseed oils were linoleic acid (56.7 $\pm$ 1.61%), palmitic acid (23.0 $\pm$ 1.09%), oleic acid (15.0 $\pm$ 1.11%) and stearic acid (2.29 $\pm$ 0.11%) and these values are fairly similar to those previously reported for different varieties (Iverson, 1969; Lawhon et al 1977). Across all the varieties analysed, linoleic acid, the major component, ranged from a low of 53.3% to a high of 59.9%. These values are slightly higher than those reported by Badami et al (1982) and Fisher and Cherry, (1983) but are similar to those of Iverson, (1969) and Lawhon et al (1977). The fatty acid compositions of the varieties containing the INGARD® gene were not significantly different from the standard varieties. Berberich et al (1996) also found that the oil composition of insect-protected cottonseed was similar to the parental lines.

In the present work, for most varieties, the CPFA accounted for about 0.5% but values ranged from means of 0.38 to 0.75% of the total fatty acids in cottonseed oil (Table7). The lowest value for CPFA was 0.38% for the variety Pima S-7 and although only two samples were obtained for analysis, the two values were consistently low (0.40 and 0.35% for samples from two seasons). Although the content of malvalic acid was low, sterculic acid was particularly low (0.09% compared with a mean and SD of 0.19 $\pm$ 0.03 % for all varieties). On the other hand, individual values of CPFA for some varieties approached 0.8% (eg. CS8S) with malvalic acid being 0.5%.

It should be noted that Pima S-7 is a member of Gossypium Barbadense L. whereas all of the others are Gossypium Hirsutum L. species.

Over all varieties, malvalic acid was the major CPFA (0.38%) followed by sterculic acid (0.19%). The content of dihydrosterculic acid (0.18%) was quite similar to that of sterculic acid.

The fatty acid and CPFA composition for each individual variety of whole cottonseed is presented in Tables 8-28. Each Table contains data for one variety collected from a number of locations at the times indicated.

Effect of cottonseed quality on CPFA content of oil

During seed preparation for cotton seedstock production, immediately following delinting, cotton is sorted (using a vibrating table) into Product for sowing and Off-grade for other purposes such as oil production. CSD provided us with three cottonseed varieties sorted in this manner; Sicala 40, Sicala V-2 and Sicot 189. For each variety, the content of total CPFA was higher in the off-grade seeds being as high as 1.03% for Sicala V-2 (Table 29). Malvalic acid was the main contributor to the increased amounts. There is also an indication that off-grade seeds may have slightly lower oil content than the product grade. Although further analyses would need to be performed to confirm the significance of these findings, it would appear that oil from the off-grade seeds may have a higher CPFA content. Overall, fatty acid composition was not markedly different across the grades.

Composition of oils from cottonseed meals

Although the oil content of the cottonseed meals was only about 3.4% (compared with 20.6% for linted whole cottonseeds) the fatty acid composition (percentage distribution), including CPFA, was essentially the same as that found for whole cottonseeds (Table 5). Thus there was no loss of CPFAs, relative to other fatty acid components, during production of the meal.

5 Discussion

Twenty-five varieties of Australian cottonseeds were analysed for their oil contents, fatty acid compositions and for their CPFA contents. Whole cottonseeds were obtained from four locations ranging from central NSW to central Queensland. Most varieties from Wee Waa, NSW were obtained from two growing seasons.

The oil contents of the whole cottonseeds was about 21% and 23% for linted and delinted respectively, and although differences were observed between varieties, it is likely that these differences were not significant. For the purposes of this study, the method used for oil extraction involved the use of only small quantities of seeds (about 1g) yielding about 200mg oil. Even though extensive washing of the residue was performed, errors for any one measurement were higher than would be expected for larger amounts of seeds. None-the-less, the oil contents obtained fell within the expected range of reported values. The final exhaustive solvent extraction gave an oil, that when hydrolysed and methylated, gave an identical fatty acid and CPFA composition as the initial extraction demonstrating that none of the fatty acids were selectively extracted by the procedure used.

The oil content of the cottonseed meal was about 3-4%, markedly less than that for whole cottonseed. This infers that cottonseed meal, at the normal levels of inclusion in feeds, would be unlikely to contribute significant amounts of CPFA.

The percentage of CPFA in whole cottonseeds was in the range expected from published work and differences between varieties were minimal except for Pima S-7. All other varieties were from the species Gossypium hirsutum L. whereas Pima S-7 is a member of Gossypium barbadense L., which may account for the differences observed. These findings are in agreement with those of Pandey and Suri (1982) although their absolute values were somewhat higher.

It is understood that Pima S-7 is currently grown predominantly in one area of NSW and requires a different ginning process (roller instead of saw gin). A potential advantage for the feedlot industry, apart from its lower CPFA content, is that whole cottonseed of Pima S-7 would be readily identifiable from a particular gin; not requiring gins to keep product separate.

There is some evidence that off-grade cottonseeds have higher percentages of CPFA in the oil and therefore these should be avoided. However, it is unlikely that, given the cottonseed industry structure that these delinted seeds would be available as cattle feeds.

6 Conclusion

There were essentially no differences in the oil and CPFA contents in twenty-five different varieties of whole cottonseeds obtained from several locations (some over two seasons) in Australia and the contents were similar to those values reported for other varieties from other countries. There is one exception and that is Pima S-7 that has significantly lower CPFA content. There may be some advantages for the feedlot industry in exploring the availability and acceptability of Pima S-7 as a feed ingredient.

It is therefore concluded that for the purposes of the feedlot industry, there is no advantage to be gained by selecting any individual variety of whole cottonseed over another, given the current availability of Pima S-7. Furthermore, its acceptability as a cattle feed may need to be evaluated.

The oil content (and thus CPFA content) of cottonseed meal is about one-fifth of that present in whole cottonseed, therefore it is possible to feed the meal at a higher level than whole seed.

7 Further work

A rigorous feeding trial should be performed to determine the maximum amount of whole cottonseeds that can be included in feedlot rations without causing excessively hard carcase fat.

Consideration should be given to pre-treatment the whole cottonseed in order to increase the chances of ruminal hydrogenation and thus inactivation of the CPFA. This could be tested initially under laboratory conditions with rumen fluid.

8 Acknowledgements

We wish to thank staff of Cotton Seed Distributors Ltd, Wee Waa, NSW, Deltapine Australia Pty Ltd, Narromine, NSW, Queensland Cotton, Brisbane, Dalby and Moura for their cooperation in obtaining whole cottonseed for this project.

We are particularly grateful to Sharon Rablin for overall management of the seed collection, for oil extraction and for preparation of the methyl esters, to Robert Dickinson for assistance with seed collection and to Maree Brewster for GLC analysis and for data preparation.

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10 Appendices

LIST OF TABLES

Table 1. Suppliers, location and varieties of cottonseeds analysed for CPFA

	DeltaPine	Cotton Seed Distributors		Queensland Cotton	
	Narromine	Wee Waa		Dalby	Moura
	December 1998	December 1998	June 1999	June 1999	June 1999
DeltaPearl	5D[#], 5L			1L	1L
DeltaGem	5D				
DeltaOpal	5D, 5L			1L	
DeltaEmerald				1L	1L
DeltaJewel	5D, 5L				1L
DP 5415				1L	1L
DP 5690	5D				
DPX4642					1L
NuCOTN 37				1L	1L
Sicala V-2		7D, 7L	1L	1L	
Sicala V-2i				1L	
Siokra V-16		1L	1L		1L
Siokra V-15		1L	1L	1L	1L
Siokra V-15i				1L	
Sicot 189		1L	2D, 1L	1L	2L
Sicot 189i				1L	1L
Sicala 40		1D	1L	1L	1L
CS 50		1L	1L	1L	1L
Sicot 50i					1L
Siokra L-23		1D			1L
CS 8S		1L			
Siokra S-101		1L	1L		
Siokra 1-4		1L		1L	1L
Siokra L-22				1L	
Pima S-7		1L	1L		

[#] Number of linted (L) and delinted (D) samples analysed; Delinted *Off-grade* and *Product* samples were also obtained for the varieties Sicala V-2, Sicala 40 and Sicot 189 from CSD.

Table 2. Fatty acid composition (% distribution), including cyclopropenoic fatty acids of various plant oils determined by GLC using two different temperature profiles

		Cotton Seed		Sterculia foetida Seed		Flame Tree Seed	
		Normal	180^{0}C	Normal	180^{0}C	Normal	180^{0}C
Fatty Acids							
Myristic	14:0	0.65	0.65	0.12	0.12	0.16	0.17
Palmitic	16:0	23.9	24.0	20.2	19.9	18.6	19.0
Palmitoleic	16:1	0.44	0.43	0.30	0.29	0.12	0.13
Stearic	18:0	2.34	2.32	1.88	1.83	3.83	3.89
Oleic	18:1c(9)	13.7	13.9	6.17	6.11	15.1	15.3
Cis-Vaccenic	18:1c(11)	0.90	0.77	1.01	1.01	1.11	0.81
Linoleic	18:2	56.8	57.0	6.54	6.72	45.7	45.6
Linolenic	18:3	0.12	0.22	1.20	6.45		
CPFA and DHS							
Malvalic		0.38	0.39	6.89	6.33	10.4	10.6
Sterculic		0.24	0.30	53.8	48.9	3.51	3.59
Dihydrosterculic		0.20	0.12	0.99	0.72	nd[#]	nd
Total CPFA		0.83	0.81	61.7	56.0	13.9	14.2

[#] Not detected

Table 3. Oil contents (% wt) of whole cottonseeds

Variety	Supplier	Date	Oil Content (%)	
			Linted	Delinted
DeltaEmerald	Qld Cotton(D[#])	Jun-99	19.2	
DeltaEmerald	Qld Cotton(M[##])	Jun-99	23.6	
DeltaGem	DeltaPine	Dec-98		26.0
DeltaJewel	DeltaPine	Dec-98	14.0	19.2
DeltaJewel	Qld Cotton(M)	Jun-99	24.7	
DeltaOpal	DeltaPine	Dec-98	22.3	21.8
DeltaOpal	Qld Cotton(D)	Jun-99	21.4	
DeltaPearl	DeltaPine	Dec-98	18.2	22.4
DeltaPearl	Qld Cotton(M)	Jun-99	20.7	
DeltaPearl	Qld Cotton(D)	Jun-99	18.1	
DP5415	Qld Cotton(D)	Jun-99	18.1	
DP5415	Qld Cotton(M)	Jun-99	20.4	
DP5690	DeltaPine	Dec-98		24.1
DPX4642	Qld Cotton(M)	Jun-99	21.2	
CS50	CSD	Dec-98	16.5	
CS50	CSD	Jun-99	16.9	
CS50	Qld Cotton(D)	Jun-99	19.9	
CS50	Qld Cotton(M)	Jun-99	20.3	
CS85	CSD	Dec-98	20.0	
NuCOTN 37	Qld Cotton(D)	Jun-99	17.4	
NuCOTN 37	Qld Cotton(M)	Jun-99	21.8	
Pima S-7	CSD	Jun-99	23.8	
Pima S-7	CSD	Dec-98	22.6	
Sicala 40	CSD	Dec-98		24.5
Sicala 40	CSD	Jun-99	20.6	
Sicala 40	Qld Cotton(D)	Jun-99	20.3	
Sicala 40	Qld Cotton(M)	Jun-99	22.3	
Sicala 40 (product)	CSD	Jun-99		25.4
Sicala 40 (off-grade)	CSD	Jun-99		21.5
Sicala V-2	CSD	Dec-98	21.4	25.4
Sicala V-2	CSD	Jun-99	21.0	
Sicala V-2	Qld Cotton(D)	Jun-99	21.1	
Sicala V-2i	Qld Cotton(D)	Jun-99	20.7	
Sicala V-2 (off-grade)	CSD	Dec-98		21.1

Table 3 Cont. Oil contents (% wt) of whole cottonseeds				
Variety	**Supplier**	**Date**	**Oil Content (%)**	
			Linted	Delinted
Sicot 189	CSD	Jun-99	20.4	
Sicot 189	Qld Cotton(D)	Jun-99	19.5	
Sicot 189	Qld Cotton(M)	Jun-99	21.9	
Sicot 189	Qld Cotton(M)	Jun-99	21.5	
Sicot 189	CSD	Dec-98	21.2	
Sicot 189i	Qld Cotton(D)	Jun-99	18.4	
Sicot 189i	Qld Cotton(M)	Jun-99	20.5	
Sicot 189 (product)	CSD	Jun-99		24.9
Sicot 189 (black seed)	CSD	Jun-99		24.9
Sicot 189 (off-grade)	CSD	Jun-99		19.0
Sicot 189 (off-grade)	CSD	Jun-99		20.7
Sicot 50i	Qld Cotton(M)	Jun-99	21.0	
Siokra 1-4	CSD	Dec-98	20.6	
Siokra 1-4	Qld Cotton(D)	Jun-99	20.8	
Siokra 1-4	Qld Cotton(M)	Jun-99	21.5	
Siokra L-22	Qld Cotton(D)	Jun-99	22.6	
Siokra L23	CSD	Dec-98		24.1
Siokra L23	Qld Cotton(M)	Jun-99	20.9	
Siokra S101	CSD	Dec-98	19.4	
Siokra S101	CSD	Jun-99	23.2	
Siokra V-15	CSD	Dec-98	21.5	
Siokra V-15	CSD	Jun-99	20.4	
Siokra V-15	Qld Cotton(D)	Jun-99	21.1	
Siokra V-15	Qld Cotton(M)	Jun-99	21.6	
Siokra V-15I	Qld Cotton(D)	Jun-99	21.0	
Siokra V-16	CSD	Dec-98	22.1	
Siokra V-16	CSD	Jun-99	20.4	
Siokra V-16	Qld Cotton(D)	Jun-99	22.0	
Siokra V-16	Qld Cotton(M)	Jun-99	21.5	
Other (unknown)	Qld Cotton(D)	Jun-99	19.8	
Mean ± SD			20.6 ± 1.88	23.0 ± 2.33

[#] Dalby, Queensland
[##] Moura, Queensland

Table 4. Oil content and fatty acid composition (% distribution), including cyclopropenoic fatty acids of Cottonseed Feed

Feedlot		1	2	3	4	5	6	7	8	9	10	11	12	Mean	SD
Fatty Acids															
Myristic	14:0	0.60	0.79	0.70	0.77	0.63	0.64	0.59	0.72	0.59	0.72	0.61	0.67	0.67	0.07
Palmitic	16:0	24.33	24.14	25.12	23.92	23.76	23.22	23.54	24.96	22.30	25.31	22.99	24.05	24.05	0.95
Palmitoleic	16:1	0.46	0.52	0.49	0.48	0.48	0.43	0.44	0.46	0.58	0.49	0.41	0.445	0.47	0.05
Stearic	18:0	2.59	2.44	2.44	2.43	2.29	2.60	2.43	2.38	2.42	2.43	2.49	2.43	2.45	0.09
Oleic	18:1c(9)	14.57	15.82	16.51	15.95	15.90	14.57	14.62	15.29	18.72	16.02	14.08	15.04	15.59	1.22
Cis-Vaccenic	18:1c(11)	0.68	0.74	0.72	0.73	0.72	0.66	0.67	0.72	0.73	0.71	0.79	0.82	0.73	0.05
Linoleic	18:2	55.27	53.07	52.48	54.15	54.70	56.36	56.21	53.86	53.04	52.79	57.30	55.23	54.54	1.57
Linolenic	18:3	0.15	0.12	0.13	0.14	0.13	0.14	0.13	0.12	0.13	0.13	0.00	0.00	0.12	0.03
CPFA and DHS															
Malvalic		0.41	0.35	0.36	0.34	0.35	0.39	0.41	0.38	0.35	0.37	0.37	0.32	0.37	0.03
Sterculic		0.13	0.13	0.15	0.15	0.16	0.16	0.15	0.21	0.13	0.15	0.16	0.16	0.15	0.03
Dihydrosterculic		0.18	0.20	0.22	0.19	0.23	0.18	0.18	0.21	0.14	0.20	0.18	0.18	0.19	0.03
Total CPFA		0.55	0.48	0.51	0.49	0.51	0.56	0.56	0.59	0.48	0.53	0.53	0.48	0.52	0.04
Oil Content (% by wt)		14.1	14.0	15.7	11.3	16.2	13.8	18.6	14.9	24.2	20.2	21.0	20.1	17.0	4.0

Table 5. Oil content and fatty acid composition (% distribution), including cyclopropenoic fatty acids of Cottonseed Meal

Supplier		1	2	3	4	5	6	Mean	SD
Fatty Acids									
Myristic	14:0	0.52	0.60	0.56	0.55	0.51	0.56	0.55	0.03
Palmitic	16:0	22.61	23.57	22.68	23.12	22.59	23.97	23.09	0.55
Palmitoleic	16:1	0.37	0.41	0.42	0.37	0.37	0.41	0.39	0.03
Stearic	18:0	2.50	2.60	2.40	2.60	2.53	2.66	2.55	0.09
Oleic	18:1c(9)	15.11	16.43	16.15	15.67	15.11	16.10	15.76	0.54
Cis-Vaccenic	18:1c(11)	0.80	0.92	0.87	0.83	0.84	0.86	0.85	0.05
Linoleic	18:2	56.56	53.81	55.33	55.32	56.36	53.77	55.19	1.15
Linolenic	18:3	0.00	0.00	0.27	0.00	0.16	0.00	0.07	0.04
CPFA and DHS									
Malvalic		0.28	0.14	0.25	0.22	0.26	0.26	0.23	0.05
Sterculic		0.20	0.14	0.22	0.18	0.21	0.20	0.19	0.03
Dihydrosterculic		0.23	0.27	0.20	0.23	0.24	0.25	0.24	0.03
Total CPFA		0.48	0.29	0.46	0.40	0.46	0.46	0.43	0.07
Oil Content (% by wt)		3.4	3.0	4.6	3.1	3.2	3.1	3.4	0.6

Table 6. Variation in fatty acid composition (% distribution), including cyclopropenoic fatty acids of Cottonseed

		DeltaJewel				DeltaOpal				DeltaPearl				DP5690		Sicala V-2	
		Delinted	%CV	Linted	%CV	Delinted	%CV	Linted	%CV	Delinted	%CV	Linted	%CV	Delinted	%CV	Linted	%CV
Fatty Acids		(n=5)		(n=5)		(n=5)		(n=5)		(n=5)		(n=5)		(n=5)		(n=7)	
Myristic	14:0	0.70	5.03	0.68	4.77	0.65	4.01	0.62	5.50	0.60	3.32	0.60	3.87	0.70	4.11	0.64	5.95
Palmitic	16:0	23.40	1.47	23.29	1.16	23.00	1.69	23.02	1.38	22.17	1.18	22.31	0.91	24.38	1.92	24.71	2.07
Palmitoleic	16:1	0.46	2.53	0.46	5.23	0.44	2.63	0.43	3.99	0.45	2.05	0.45	5.48	0.47	3.66	0.47	2.47
Stearic	18:0	2.53	4.23	2.55	2.89	2.36	4.10	2.43	2.63	2.36	2.44	2.36	4.09	2.04	6.01	2.32	2.68
Oleic	18:1c(9)	16.22	1.63	16.46	1.72	15.17	2.89	15.24	1.86	14.54	2.73	14.40	2.86	15.15	1.18	15.53	2.34
Cis-Vaccenic	18:1c(11)	0.62	3.38	0.63	3.38	0.63	2.18	0.62	4.65	0.64	2.41	0.63	3.90	0.70	2.67	0.65	3.09
Linoleic	18:2	54.58	0.92	54.43	0.81	56.35	1.34	56.26	1.09	57.67	1.27	57.53	0.92	54.82	0.74	53.93	1.04
Linolenic	18:3	0.17	10.50	0.19	7.90	0.14	2.70	0.15	9.56	0.15	5.37	0.18	12.07	0.14	4.05	0.14	13.33
CPFA and DHS																	
Malvalic		0.31	6.90	0.32	8.37	0.38	10.1	0.38	5.26	0.36	7.98	0.35	7.10	0.36	4.35	0.38	6.38
Sterculic		0.10	18.87	0.11	12.92	0.14	20.5	0.12	9.04	0.13	8.93	0.14	12.67	0.18	21.25	0.18	16.11
Dihydrosterculic		0.19	5.60	0.19	9.99	0.16	8.72	0.16	5.81	0.18	11.7	0.18	12.50	0.19	9.52	0.24	4.56
Total CPFA		0.41	8.93	0.44	9.32	0.52	8.97	0.50	6.72	0.50	7.73	0.50	7.14	0.54	7.77	0.56	8.00

Table 7. Fatty acid composition (% distribution), including cyclopropenoic fatty acids of all varieties of whole cottonseeds

Variety	14:0	16:0	16:1	18:0	Mal[#]	18:1c(9)	18:1c(11)	Ster[#]	DHS[#]	18:2	20:0	18:3c	Total CPFA ± SD
DeltaPearl	0.60	22.1	0.44	2.30	0.35	14.3	0.72	0.18	0.17	58.2	0.20	0.15	0.53 ± 0.04
DeltaGem	0.60	22.4	0.39	2.33	0.46	15.6	0.61	0.18	0.19	56.6	0.22	0.16	0.64
DeltaOpal	0.65	22.7	0.42	2.36	0.42	14.9	0.69	0.19	0.18	57.0	0.22	0.15	0.58 ± 0.11
DeltaEmerald	0.53	19.7	0.46	2.19	0.40	15.4	0.86	0.20	0.21	59.9	0.19	0.14	0.59
DeltaJewel	0.66	23.4	0.45	2.52	0.31	15.9	0.69	0.13	0.17	55.1	0.25	0.16	0.44 ± 0.029
DP5415	0.60	25.5	0.58	2.10	0.35	13.2	0.92	0.19	0.15	56.3	0.21	0.15	0.54
DP5690	0.70	24.4	0.47	2.28	0.36	15.2	0.70	0.18	0.19	54.8	0.23	0.14	0.54
DPX4642	0.62	23.4	0.4	2.31	0.38	13.9	0.86	0.2	0.19	57.6	0.2	0.12	0.58
NuCOTN 37	0.65	23.1	0.43	2.26	0.38	13.4	0.80	0.23	0.16	58.3	0.23	0.15	0.61
Sicala V-2	0.65	24.3	0.49	2.34	0.35	15.7	0.73	0.20	0.23	54.4	0.26	0.14	0.56 ± 0.009
Sicala V-2i	0.56	21.6	0.44	2.17	0.42	14.8	0.82	0.17	0.23	58.5	0.24	0.13	0.59
Siokra V-16	0.71	24.1	0.49	2.25	0.35	14.7	0.81	0.20	0.19	55.8	0.24	0.12	0.55 ± 0.079
Siokra V-15	0.73	23.9	0.47	2.38	0.36	15.6	0.83	0.18	0.17	55.0	0.25	0.15	0.54 ± 0.041
Siokra V-15i	0.67	22.8	0.51	2.14	0.36	14.5	0.82	0.23	0.2	57.5	0.21	0.13	0.59
Sicot 189	0.61	22.5	0.42	2.32	0.37	13.6	0.79	0.21	0.16	58.7	0.23	0.14	0.58 ± 0.051
Sicot 189i	0.64	22.5	0.44	2.21	0.35	14.1	0.83	0.21	0.17	58.3	0.21	0.14	0.56
Sicala 40	0.67	23.6	0.47	2.22	0.39	15.8	0.80	0.17	0.19	55.3	0.23	0.13	0.56 ± 0.038
CS50	0.60	22.8	0.42	2.15	0.44	14.6	0.67	0.14	0.15	57.2	0.20	0.15	0.61 ± 0.076
Sicot 50i	0.62	22.9	0.44	2.32	0.32	14.5	0.78	0.19	0.15	57.6	0.21	0.13	0.51
Siokra L23	0.69	23.5	0.43	2.30	0.37	14.6	0.78	0.18	0.20	56.5	0.22	0.12	0.55
CS8S	0.65	23.3	0.43	2.31	0.50	16.1	0.68	0.25	0.20	54.7	0.24	0.18	0.75
Siokra S-101	0.58	22.4	0.41	2.52	0.36	15.6	0.69	0.18	0.19	56.5	0.25	0.14	0.55
Siokra 1-4	0.64	22.8	0.48	2.41	0.35	15.4	0.75	0.18	0.17	56.4	0.22	0.15	0.53 ± 0.087
Siokra L22	0.71	22.5	0.43	2.21	0.39	14.2	0.81	0.24	0.17	58.1	0.21	0.13	0.63
Pima S-7	0.59	22.5	0.62	2.43	0.29	18.6	0.70	0.09	0.11	53.3	0.33	0.15	0.38
Mean	0.64	23.0	0.46	2.29	0.38	15.0	0.77	0.19	0.18	56.7	0.23	0.14	0.56
± SD	0.05	1.09	0.05	0.11	0.05	1.11	0.07	0.03	0.03	1.61	0.03	0.01	0.067

[#] Mal, malvalic acid; Ster, sterculic acid; DHS, dihydrosterculic acid

Table 8. Oil content and fatty acid composition (% distribution), including cyclopropenoic fatty acids of DeltaPearl

Supplier		DeltaPine		Qld Cotton	
Location		Narromine		Dalby	Moura
		Dec-98	Dec-98	Jun-99	Jun-99
Fatty Acids		Delinted	Linted	Linted	Linted
Myristic	14:0	0.60	0.60	0.63	0.57
Palmitic	16:0	22.17	22.31	21.40	22.69
Palmitoleic	16:1	0.45	0.45	0.44	0.42
Stearic	18:0	2.36	2.36	2.16	2.33
Oleic	18:1c(9)	14.54	14.40	14.21	13.95
Cis-Vaccenic	18:1c(11)	0.64	0.63	0.83	0.79
Linoleic	18:2	57.67	57.53	59.32	58.35
Linolenic	18:3	0.15	0.18	0.16	0.11
CPFA and DHS					
Malvalic		0.36	0.35	0.36	0.33
Sterculic		0.13	0.14	0.22	0.21
Dihydrosterculic		0.18	0.18	0.18	0.15
Total CPFA		0.50	0.50	0.57	0.54
Oil Content (% by wt)		22.4	18.2	18.1	20.7

Table 9. Oil content and fatty acid composition (% distribution), including cyclopropenoic fatty acids of DeltaGem

Supplier		DeltaPine
Location		Narromine
		Dec-98
Fatty Acids		Delinted
Myristic	14:0	0.60
Palmitic	16:0	22.36
Palmitoleic	16:1	0.39
Stearic	18:0	2.33
Oleic	18:1c(9)	15.55
Cis-Vaccenic	18:1c(11)	0.61
Linoleic	18:2	56.59
Linolenic	18:3	0.16
CPFA and DHS		
Malvalic		0.46
Sterculic		0.18
Dihydrosterculic		0.19
Total CPFA		0.64
Oil Content (% by wt)		26.0

Table 10. Oil content and fatty acid composition (% distribution), including cyclopropenoic fatty acids of DeltaOpal

Supplier		**DeltaPine**		**Qld Cotton**
Location		**Narromine**		**Dalby**
		Dec-98	**Dec-98**	**Jun-99**
Fatty Acids		**Delinted**	**Linted**	**Linted**
Myristic	14:0	0.65	0.62	0.68
Palmitic	16:0	23.00	23.02	22.28
Palmitoleic	16:1	0.44	0.43	0.41
Stearic	18:0	2.36	2.43	2.29
Oleic	18:1c(9)	15.17	15.24	14.54
Cis-Vaccenic	18:1c(11)	0.63	0.62	0.77
Linoleic	18:2	56.35	56.26	57.84
Linolenic	18:3	0.14	0.15	0.16
CPFA and DHS				
Malvalic		0.38	0.38	0.46
Sterculic		0.14	0.12	0.25
Dihydrosterculic		0.16	0.16	0.19
Total CPFA		0.52	0.50	0.71
Oil Content (% by wt)		21.8	22.3	21.4

Table 11. Oil content and fatty acid composition (% distribution), including cyclopropenoic fatty acids of DeltaEmerald

Supplier		**Qld Cotton**	
Location		**Dalby**	**Moura**
		Jun-99	**Jun-99**
Fatty Acids		**Linted**	**Linted**
Myristic	14:0	0.55	0.51
Palmitic	16:0	19.28	20.16
Palmitoleic	16:1	0.45	0.46
Stearic	18:0	2.18	2.19
Oleic	18:1c(9)	15.42	15.29
Cis-Vaccenic	18:1c(11)	0.88	0.84
Linoleic	18:2	60.15	59.59
Linolenic	18:3	0.16	0.12
CPFA and DHS			
Malvalic		0.42	0.37
Sterculic		0.17	0.22
Dihydrosterculic		0.22	0.19
Total CPFA		0.59	0.59
Oil Content (% by wt)		19.2	23.7

Table 12. Oil content and fatty acid composition (% distribution), including cyclopropenoic fatty acids of DeltaJewel				
Supplier		**DeltaPine**		**Qld Cotton**
Location		**Narromine**		**Moura**
		Dec-98	**Dec-98**	**Jun-99**
Fatty Acids		**Delinted**	**Linted**	**Linted**
Myristic	14:0	0.70	0.68	0.60
Palmitic	16:0	23.40	23.29	23.62
Palmitoleic	16:1	0.46	0.46	0.45
Stearic	18:0	2.53	2.55	2.49
Oleic	18:1c(9)	16.22	16.46	14.90
Cis-Vaccenic	18:1c(11)	0.62	0.63	0.81
Linoleic	18:2	54.58	54.43	56.25
Linolenic	18:3	0.17	0.19	0.13
CPFA and DHS				
Malvalic		0.31	0.32	0.29
Sterculic		0.10	0.11	0.18
Dihydrosterculic		0.19	0.19	0.14
Total CPFA		0.41	0.44	0.47
Oil Content (% by wt)		19.2	14.1	24.7

Table 13. Oil content and fatty acid composition (% distribution), including cyclopropenoic fatty acids of DP 5415			
Supplier		**Qld Cotton**	
Location		**Dalby**	**Moura**
		Jun-99	**Jun-99**
Fatty Acids		**Linted**	**Linted**
Myristic	14:0	0.60	0.59
Palmitic	16:0	24.57	26.35
Palmitoleic	16:1	0.57	0.59
Stearic	18:0	2.07	2.12
Oleic	18:1c(9)	13.06	13.33
Cis-Vaccenic	18:1c(11)	0.90	0.93
Linoleic	18:2	57.33	55.21
Linolenic	18:3	0.16	0.14
CPFA and DHS			
Malvalic		0.38	0.32
Sterculic		0.17	0.20
Dihydrosterculic		0.15	0.14
Total CPFA		0.56	0.52
Oil Content (% by wt)		18.1	20.1

Table 14. Oil content and fatty acid composition (% distribution), including cyclopropenoic fatty acids of DP 5690		
Supplier		**DeltaPine**
Location		**Narromine**
		Dec-98
Fatty Acids		**Delinted**
Myristic	14:0	0.70
Palmitic	16:0	24.38
Palmitoleic	16:1	0.47
Stearic	18:0	2.04
Oleic	18:1c(9)	15.15
Cis-Vaccenic	18:1c(11)	0.70
Linoleic	18:2	54.82
Linolenic	18:3	0.14
CPFA and DHS		
Malvalic		0.36
Sterculic		0.18
Dihydrosterculic		0.19
Total CPFA		0.54
Oil Content (% by wt)		24.1

Table 15. Oil content and fatty acid composition (% distribution), including cyclopropenoic fatty acids of NuCOTN 37			
Supplier		**Qld Cotton**	
Location		**Dalby**	**Moura**
		Jun-99	**Jun-99**
Fatty Acids		**Linted**	**Linted**
Myristic	14:0	0.66	0.64
Palmitic	16:0	22.63	23.55
Palmitoleic	16:1	0.42	0.44
Stearic	18:0	2.24	2.28
Oleic	18:1c(9)	13.41	13.46
Cis-Vaccenic	18:1c(11)	0.76	0.84
Linoleic	18:2	58.90	57.78
Linolenic	18:3	0.17	0.13
CPFA and DHS			
Malvalic		0.41	0.35
Sterculic		0.22	0.23
Dihydrosterculic		0.18	0.14
Total CPFA		0.63	0.58
Oil Content (% by wt)		17.4	21.8

Table 16. Oil content and fatty acid composition (% distribution), including cyclopropenoic fatty acids of Sicala V-2 (and Sicala V-2i)

Supplier			**CSD**		**Qld Cotton**	
Location			**Wee Waa**		**Dalby**	**Dalby** (SicalaV-2i)
		Dec-98	**Dec-98**	**Jun-99**	**Jun-99**	**Jun-99**
Fatty Acids		**Delinted**	**Linted**	Linted	**Linted**	**Linted**
Myristic	14:0	0.64	0.64	0.63	0.70	0.56
Palmitic	16:0	24.94	24.71	24.11	23.54	21.63
Palmitoleic	16:1	0.47	0.47	0.47	0.54	0.44
Stearic	18:0	2.46	2.32	2.32	2.25	2.17
Oleic	18:1c(9)	16.30	15.53	15.53	15.57	14.84
Cis-Vaccenic	18:1c(11)	0.67	0.65	0.76	0.86	0.82
Linoleic	18:2	52.98	53.93	55.14	55.48	58.48
Linolenic	18:3	0.14	0.14	0.24	0.15	0.13
CPFA and DHS						
Malvalic		0.36	0.38	0.36	0.32	0.42
Sterculic		0.19	0.18	0.21	0.24	0.17
Dihydrosterculic		0.22	0.24	0.21	0.26	0.23
Total CPFA		0.55	0.56	0.57	0.55	0.59
Oil Content (% by wt)		25.4	21.4	21.0	21.1	20.7

Table 17. Oil content and fatty acid composition (% distribution), including cyclopropenoic fatty acids of Siokra V-16

Supplier		**CSD**		**Qld Cotton**	
Location		**Wee Waa**		**Dalby**	**Moura**
		Dec-98	**Jun-99**	**Jun-99**	**Jun-99**
Fatty Acids		**Linted**	Linted	**Linted**	**Linted**
Myristic	14:0	0.70	0.74	0.67	0.72
Palmitic	16:0	24.52	24.53	23.07	24.45
Palmitoleic	16:1	0.50	0.50	0.45	0.50
Stearic	18:0	2.37	2.25	2.14	2.22
Oleic	18:1c(9)	14.88	15.61	13.70	14.60
Cis-Vaccenic	18:1c(11)	0.68	0.88	0.85	0.84
Linoleic	18:2	54.85	54.38	58.10	55.83
Linolenic	18:3	0.14	0.12	0.12	0.09
CPFA+DHS					
Malvalic		0.40	0.38	0.36	0.25
Sterculic		0.14	0.21	0.26	0.19
Dihydrosterculic		0.20	0.21	0.18	0.17
Total CPFA		0.54	0.59	0.63	0.44
Oil Content (% by wt)		22.1	20.4	22.0	21.5

Table 18. Oil content and fatty acid composition (% distribution), including cyclopropenoic fatty acids of Siokra V-15 (and Siokra V-15i)						
Supplier		**CSD**		**Qld Cotton**		
Location		**Wee Waa**		**Dalby**	**Moura**	**Dalby** (SiokraV-15i)
		Dec-98	**Jun-99**	**Jun-99**	**Jun-99**	**Jun-99**
Fatty Acids		**Linted**	Linted	**Linted**	**Linted**	**Linted**
Myristic	14:0	0.71	0.74	0.74	0.74	0.67
Palmitic	16:0	24.40	24.39	23.13	23.84	22.80
Palmitoleic	16:1	0.48	0.48	0.44	0.47	0.51
Stearic	18:0	2.41	2.35	2.19	2.56	2.14
Oleic	18:1c(9)	15.32	15.27	15.50	16.11	14.51
Cis-Vaccenic	18:1c(11)	0.70	0.90	0.86	0.85	0.82
Linoleic	18:2	54.43	54.82	56.15	54.60	57.48
Linolenic	18:3	0.16	0.12	0.18	0.12	0.13
CPFA and DHS						
Malvalic		0.41	0.35	0.38	0.30	0.36
Sterculic		0.15	0.22	0.19	0.17	0.23
Dihydrosterculic		0.20	0.16	0.21	0.13	0.20
Total CPFA		0.55	0.56	0.57	0.47	0.59
Oil Content (% by wt)		21.5	20.5	21.1	21.6	21.0

Table 19. Oil content and fatty acid composition (% distribution), including cyclopropenoic fatty acids of Sicot 189 (and Sicot 189i)						
Supplier		**CSD**		**Qld Cotton**		
Location		**Wee Waa**		**Dalby**	**Moura**	**Dalby** (Sicot 189i)
		Dec-98	**Jun-99**	**Jun-99**	**Jun-99**	**Jun-99**
Fatty Acids		**Linted**	Linted	**Linted**	**Linted**	**Linted**
Myristic	14:0	0.61	0.62	0.60	0.66	0.58
Palmitic	16:0	23.14	21.87	21.48	23.29	21.45
Palmitoleic	16:1	0.43	0.39	0.41	0.43	0.45
Stearic	18:0	2.37	2.27	2.25	2.34	2.14
Oleic	18:1c(9)	13.63	13.38	13.47	13.88	14.16
Cis-Vaccenic	18:1c(11)	0.62	0.81	0.87	0.83	0.82
Linoleic	18:2	57.65	59.65	59.84	57.65	59.44
Linolenic	18:3	0.14	0.17	0.14	0.13	0.15
CPFA and DHS						
Malvalic		0.39	0.39	0.38	0.31	0.38
Sterculic		0.16	0.26	0.23	0.21	0.21
Dihydrosterculic		0.16	0.16	0.15	0.19	0.18
Total CPFA		0.55	0.66	0.60	0.52	0.59
Oil Content (% by wt)		21.2	20.4	19.5	21.9	18.5

Table 20. Oil content and fatty acid composition (% distribution), including cyclopropenoic fatty acids of Sicala 40

Supplier		**CSD**		**Qld Cotton**	
Location		**Wee Waa**		**Dalby**	**Moura**
		Dec-98	**Jun-99**	**Jun-99**	**Jun-99**
Fatty Acids		**Delinted**	**Linted**	**Linted**	**Linted**
Myristic	14:0	0.67	0.70	0.62	0.69
Palmitic	16:0	24.61	23.23	22.27	24.37
Palmitoleic	16:1	0.48	0.46	0.44	0.48
Stearic	18:0	2.31	2.23	2.15	2.18
Oleic	18:1c(9)	16.39	15.57	15.60	15.53
Cis-Vaccenic	18:1c(11)	0.69	0.92	0.85	0.75
Linoleic	18:2	53.29	55.82	57.05	55.10
Linolenic	18:3	0.14	0.13	0.16	0.11
CPFA and DHS					
Malvalic		0.41	0.39	0.43	0.32
Sterculic		0.17	0.14	0.17	0.20
Dihydrosterculic		0.20	0.19	0.21	0.15
Total CPFA		0.58	0.53	0.60	0.52
Oil Content (% by wt)		24.5	20.6	20.3	22.3

Table 21. Oil content and fatty acid composition (% distribution), including cyclopropenoic fatty acids of CS 50 (and CS 50i)

Supplier		**CSD**		**Qld Cotton**		
Location		**Wee Waa**		**Dalby**	**Moura**	**Moura** (CS50i)
		Dec-98	**Jun-99**	**Jun-99**	**Jun-99**	**Jun-99**
Fatty Acids		**Linted**	Linted	**Linted**	**Linted**	**Linted**
Myristic	14:0	0.60	0.56	0.62	0.58	0.62
Palmitic	16:0	22.85	22.49	22.37	22.92	22.87
Palmitoleic	16:1	0.42	0.40	0.43	0.42	0.44
Stearic	18:0	2.15	2.29	2.08	2.36	2.32
Oleic	18:1c(9)	14.57	14.44	13.44	13.97	14.47
Cis-Vaccenic	18:1c(11)	0.67	0.76	0.72	0.69	0.78
Linoleic	18:2	57.20	58.09	59.17	58.19	57.62
Linolenic	18:3	0.15	0.14	0.17	0.13	0.13
CPFA and DHS						
Malvalic		0.44	0.39	0.44	0.34	0.32
Sterculic		0.14	0.21	0.27	0.19	0.19
Dihydrosterculic		0.15	0.15	0.16	0.15	0.15
Total CPFA		0.58	0.63	0.72	0.53	0.52
Oil Content (% by wt)		16.5	16.9	19.9	20.27	21.0

Table 22. Oil content and fatty acid composition (% distribution), including cyclopropenoic fatty acids of Siokra L23

Supplier		**CSD**	**Qld Cotton**
Location		**Wee Waa**	**Moura**
		Dec-98	**Jun-99**
Fatty Acids		**Delinted**	**Linted**
Myristic	14:0	0.66	0.73
Palmitic	16:0	23.58	23.34
Palmitoleic	16:1	0.44	0.42
Stearic	18:0	2.27	2.34
Oleic	18:1c(9)	14.30	14.98
Cis-Vaccenic	18:1c(11)	0.68	0.87
Linoleic	18:2	56.55	56.39
Linolenic	18:3	0.12	0.12
CPFA and DHS			
Malvalic		0.41	0.34
Sterculic		0.18	0.18
Dihydrosterculic		0.20	0.19
Total CPFA		0.59	0.52
Oil Content (% by wt)		24.2	20.9

Table 23. Oil content and fatty acid composition (% distribution), including cyclopropenoic fatty acids of CS 8S

Supplier		**CSD**
Location		**Wee Waa**
		Dec-98
Fatty Acids		**Linted**
Myristic	14:0	0.65
Palmitic	16:0	23.29
Palmitoleic	16:1	0.43
Stearic	18:0	2.31
Oleic	18:1c(9)	16.11
Cis-Vaccenic	18:1c(11)	0.68
Linoleic	18:2	54.67
Linolenic	18:3	0.18
CPFA and DHS		
Malvalic		0.50
Sterculic		0.25
Dihydrosterculic		0.20
Total CPFA		0.75
Oil Content (% by wt)		20.0

Table 24. Oil content and fatty acid composition (% distribution), including cyclopropenoic fatty acids of Siokra S-101

Supplier		**CSD**	
Location		**Wee Waa**	
		Dec-98	**Jun-99**
Fatty Acids		**Linted**	Linted
Myristic	14:0	0.58	0.59
Palmitic	16:0	22.35	22.50
Palmitoleic	16:1	0.42	0.40
Stearic	18:0	2.53	2.51
Oleic	18:1c(9)	15.44	15.75
Cis-Vaccenic	18:1c(11)	0.62	0.77
Linoleic	18:2	56.58	56.49
Linolenic	18:3	0.11	0.13
CPFA and DHS			
Malvalic		0.38	0.35
Sterculic		0.14	0.23
Dihydrosterculic		0.18	0.20
Total CPFA		0.52	0.58
Oil Content (% by wt)		19.4	23.21

Table 25. Oil content and fatty acid composition (% distribution), including cyclopropenoic fatty acids of Siokra 1-4

Supplier		**CSD**	**Qld Cotton**	
Location		**Wee Waa**	**Dalby**	**Moura**
		Dec-98	**Jun-99**	**Jun-99**
Fatty Acids		**Linted**	**Linted**	**Linted**
Myristic	14:0	0.62	0.61	0.68
Palmitic	16:0	23.21	21.88	23.34
Palmitoleic	16:1	0.48	0.46	0.51
Stearic	18:0	2.65	2.21	2.36
Oleic	18:1c(9)	15.96	15.03	15.11
Cis-Vaccenic	18:1c(11)	0.65	0.76	0.84
Linoleic	18:2	54.90	57.88	56.36
Linolenic	18:3	0.16	0.16	0.14
CPFA and DHS				
Malvalic		0.38	0.40	0.28
Sterculic		0.13	0.23	0.18
Dihydrosterculic		0.19	0.18	0.13
Total CPFA		0.51	0.63	0.46
Oil Content (% by wt)		20.6	20.8	21.5

Table 26. Oil content and fatty acid composition (% distribution), including cyclopropenoic fatty acids of Siokra L-22

Supplier		**Qld Cotton**
Location		**Dalby**
		Jun-99
Fatty Acids		**Linted**
Myristic	14:0	0.71
Palmitic	16:0	22.47
Palmitoleic	16:1	0.43
Stearic	18:0	2.21
Oleic	18:1c(9)	14.24
Cis-Vaccenic	18:1c(11)	0.81
Linoleic	18:2	58.11
Linolenic	18:3	0.13
CPFA and DHS		
Malvalic		0.39
Sterculic		0.24
Dihydrosterculic		0.17
Total CPFA		0.64
Oil Content (% by wt)		22.6

Table 27. Oil content and fatty acid composition (% distribution), including cyclopropenoic fatty acids of DPX4642

Supplier		**Qld Cotton**
Location		**Moura**
		Jun-99
Fatty Acids		**Linted**
Myristic	14:0	0.62
Palmitic	16:0	23.38
Palmitoleic	16:1	0.40
Stearic	18:0	2.31
Oleic	18:1c(9)	13.85
Cis-Vaccenic	18:1c(11)	0.86
Linoleic	18:2	57.61
Linolenic	18:3	0.12
CPFA and DHS		
Malvalic		0.38
Sterculic		0.20
Dihydrosterculic		0.19
Total CPFA		0.57
Oil Content (% by wt)		21.2

Table 28. Oil content and fatty acid composition (% distribution), including cyclopropenoic fatty acids of Pima S-7

Supplier		**CSD**	
Location		**Wee Waa**	
		Dec-98	**Jun-99**
Fatty Acids		**Linted**	Linted
Myristic	14:0	0.59	0.58
Palmitic	16:0	23.11	21.84
Palmitoleic	16:1	0.66	0.58
Stearic	18:0	2.39	2.46
Oleic	18:1c(9)	18.19	19.10
Cis-Vaccenic	18:1c(11)	0.63	0.77
Linoleic	18:2	52.73	53.89
Linolenic	18:3	0.15	0.15
CPFA and DHS			
Malvalic		0.32	0.25
Sterculic		0.08	0.10
Dihydrosterculic		0.10	0.11
Total CPFA		0.40	0.35
Oil Content (% by wt)		22.6	23.8