Fatty Acid Composition of Coconut Oil Among the Cultivars - An Insight into Industrial Application

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Abstract

In recent times the thrust is on product diversification in coconut. This will enable the farmer to get higher remuneration to his product and thus improve the system productivity. It is important to have the knowledge about the cultivars and their specific suitability in order to optimize the diversification process. An experiment was conducted with the objectives to screen the elite germplasm for oil quality for specific industrial purposes and from the point of view of human health. Eighteen cultivars of coconut (*Cocos nucifera* L.) were taken for the study. The cultivars included local talls (WCT, LCT, ADOT and BENT), released and promising hybrids (CODx WCT; WCT x COD; LCT x COD; LCT x GBD; MYD x WCT and WCT x GBD) and geographically distinct cultivars (FJIT; PHOT; SSGT; SNRT; WAT; ZANT; JVT and FMST). The concentrations of saturated fatty acids was maximum in ADOT, LCT and SSGT, whereas, the unsaturated fatty acid concentration was maximum in LCT x GBD. The ratio of saturated to unsaturated fatty acid concentration was lowest in LCT x GBD and highest in ADOT. The hybrids, in general, had lower concentrations of saturated fatty acids and correspondingly low ratios of saturated to unsaturated fatty acid concentrations. The talls had higher values for these parameters with WCT as exception. Suitability of coconut oil for various industrial purposes can be assessed from the study.

Introduction

The knowledge about the cultivars and their specific suitability for end use is essential in order to optimize the diversification process. Coconut oil, the major high value product of coconut, is put to diversified uses. Main component of coconut oil is lauric acid (~48%) with the balance being other shorter chain fatty acids like myristic, caprylic and palmitic acids (Ohler, 1984). The significant physical property, which sets it apart from most of other oils, is its narrow range of melting point. It is one of the few vegetable oils, which can be utilized in a wide range of applications, so is often preferred to synthetic or petroleum oil based materials because of its unique characteristics. Presence of high lauric acid content makes it highly suitable for making quality soaps, detergents surfactants and shampoos. As the thrust is on product diversification, it is important to study the levels of saturated fatty acids like lauric, myristic and palmitic acids in elite germplasm collected from indigenous and exotic sources, so that varieties can be selected for specific industrial purposes.

The use of gas liquid chromatography (GLC) led to an extensive analysis of the triglycerides present in the oil leading to its fractionation into different groups based on their carbon atoms from 28 to 52 (Bezard *et al.*, 1971). The classic work on fatty acid biosynthesis in the developing endosperm of coconut was done in USA by Oo and Stumpf (1979). But so far, little attention is given to the variation in oil composition and quality among the coconut germplasm from the major coconut producing countries like Philippines, Indonesia and Sri Lanka.

Information on the variation in oil composition with respect to cultivars, and elite genotypes is lacking except for a recent report on FAs and tri acyl glyceryl (TAG) composition of oils of nine coconut hybrids indicating variation in the lauric acid content among hybrids from 47.3 to 50.5% in the oil samples (Rodriguez *et al.*, 1998). Apart from this no extensive work on similar lines has so far been reported in coconut.

Keeping in view of the present available knowledge on the quality of coconut oil, the experiment was conducted with the objective to screen the elite germplasm for oil quality from the point of view of human health. Since this Institute is endowed with world germplasm collection in coconut, it is pertinent to assess the oil quality aspects.

Analysis for Fatty Acid Profile

Eighteen cultivars of coconut (*Cocos nucifera* L.) were taken for the study. The cultivars included local talls (West Coast Tall-WCT; Laccadive Ordinary - LCT, Andaman Ordinary-ADOT and Benaulim Tall-BENT), released and promising hybrids (CODx WCT; WCT x COD; LCT x COD; LCT x GBD; MYD x WCT and WCT x GBD) and geographically distinct cultivars (Fiji Tall-FIJT; Philippines Ordinary - PHOT; SSGT; San Raman - SNRT; West African Tall - WAT; Zanzibar Tall - ZANT; Java - JVT and FMST). The palms are grown in the red sandy loam soils of the Institute with recommended agronomic practices.

Four mature nuts (tagged; 12 months old) from each palm and three palms/cultivars were taken for the study. Oil was extracted from the copra by crushing in micro-expeller. The clear oil was obtained after settling the debris in the extracted oil and filtered through glass wool. The oil samples (500 mg)

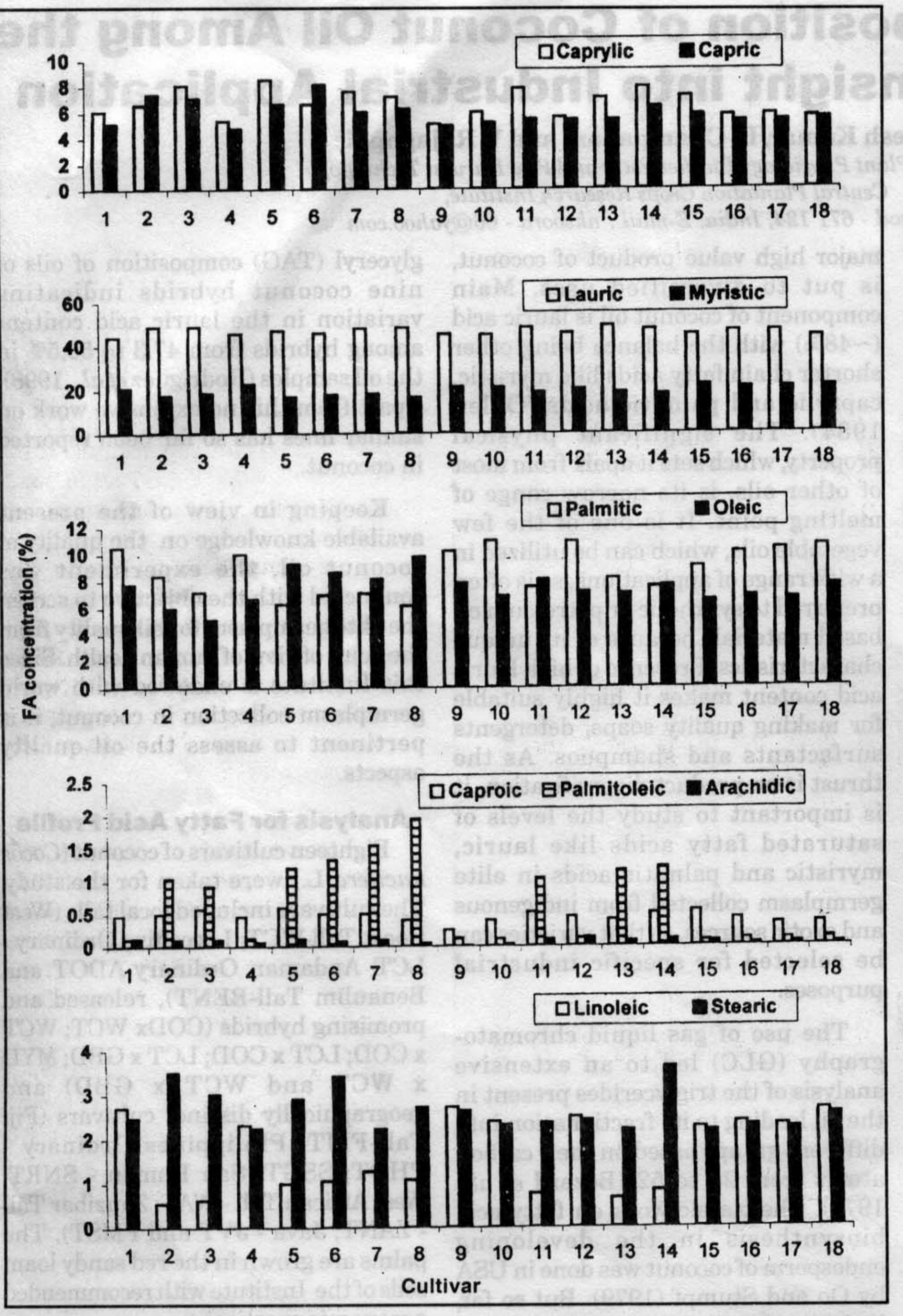

Fig 1.Variation in fatty acid concentration (%) in oil from different cultivars of coconut; 1-WCT; 2-LCT; 3-ADOT; 4-BENT; 5-COD x WCT; 6-WCT x COD; 7-LCT x COD; 8-LCT x GBD; 9-MYD x WCT; 10-WCT x GBD; 11-FIJT; 12 - PHOT; 13-SSGT; 14-SNRT; 15-WAT; 16-ZANT; 17-JVT; 18-FMST.

were used for methyl esterification and the GLC was performed following the method of Padua Resurrection and Banzon (1979). The concentration of each fatty acid was calculated by dividing the area of the fatty acid by the sum of all peak areas of fatty acids. The results were compared with the standard peak run times for identifying the specific fatty acid. Each analysis was carried out in triplicate and the mean values are reported. The data were statistically analysed in completely randomized design (CRD). Critical difference at 5% confidence level is used for comparing the means.

The results indicate that the coconut oil mainly contains the saturated fatty acids like caproic (6C), caprylic (8 C), capric (10 C), lauric (12 C), myristic (14 C), palmitic (16 C), stearic (18 C) and arachadic (20 C) in different quantities among the cultivars (*Fig. 1*). The unsaturated fatty acids in lesser quantities are oleic (18 C:1), palmitoleic (16 C:2) and linoleic (18 C:3) acids. Among the saturated fatty acids, lauric acid (46%) forms the major component. ADOT and SSGT were very rich in lauric acid, while FMST contained minimum quantity. Like wise, different saturated fatty acids exhibited variations among the cultivars. Among the unsaturated fatty acids, palmitoleic acid was maximum in LCT x GBD and minimum in WCT x GBD, ZANT and JVT, whereas, oleic acid was maximum in LCT x GBD and minimum in ADOT. WCT and MYD x WCT had high content of linoleic acid, an essential fatty acid.

The concentrations of saturated fatty acids lie maximum in ADOT, LCT, WAT and SSGT and minimum in LCT x GBD (*Fig. 2*) while the unsaturated fatty acid concentration was maximum in LCT x GBD and minimum in ADOT, LCT and SSGT. The ratio of saturated to unsaturated fatty acids was lowest in LCT x GBD and highest in ADOT. In general, the hybrids had lower concentration of saturated fatty acids and correspondingly low ratios of saturated to unsaturated fatty acid contents. The talls had higher values for these parameters; however WCT showed lower ratio.

The cultivars were ranked for different characteristic features. The following weightage was given while ranking the cultivars. (i) low ratio of saturated to unsaturated fatty acids;

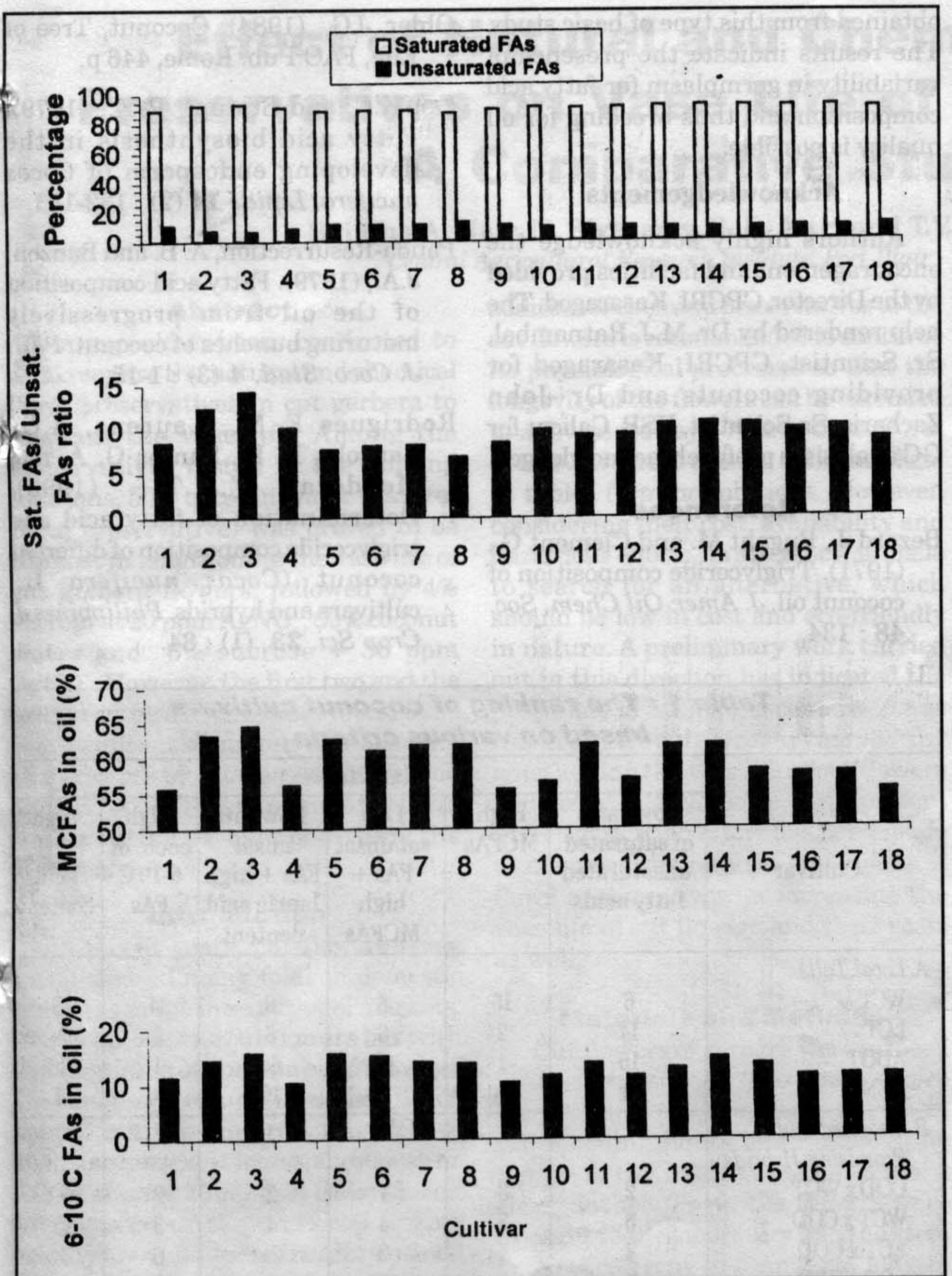

Fig 2. Variation in type of fatty acid concentration (%) in oil from different cultivars of coconut; 1-WCT; 2-LCT; 3-ADOT; 4-BENT; 5-COD x WCT; 6-WCT x COD; 7-LCT x COD; 8-LCT x GBD; 9-MYD x WCT; 10-WCT x GBD; 11-FIJT; 12-PHOT; 13-SSGT; 14-SNRT; 15-WAT; 16-ZANT; 17-JVT; 18-FMST.

(ii) high medium chain fatty acids (MCFAs); (iii) combination of (i) and (ii); (iv) Low saturated to unsaturated fatty acid ratio + high lauric acid content; (v) high concentration of 6-10C fatty acids and (vi) high lauric acid content. The *Table 1* depicts the ranking of cultivars for the above traits. LCT x GBD and COD x WCT had first two ranks for the low ratio of saturated to unsaturated fatty acids, whereas ADOT and LCT ranked high for high MCFAs. When these two characters were considered together, COD x WCT was first ranked followed by LCT x GBD. These two hybrids maintained the high rankings when the ratio of saturated to unsaturated fatty acids and high lauric acid content were combined. However, when only high lauric acid content was taken into consideration the first two ranks have gone to ADOT and LCT, respectively. The cultivar ADOT was placed in the first rank for high concentration of 6-10C fatty acids, with COD x WCT placed at second rank. Based on the rank sum, ADOT and LCT among the local talls, COD x WCT and LCT x GBD among the hybrids, and FIJT and SSGT among the exotic cultivars possessed desirable traits for various fatty acid compositions. When all the 18 cultivars were comparéd, the three hybrids COD x WCT, LCT x GBD and LCT x COD emerged as the best ones.

In crop improvement, one of the main objectives is to identify the cultivar for a given trait or traits which reflect on the over all performance and help in selection for breeding. Keeping this in view, the cultivars are arranged in order of preference for each character. The seven groups are :

1. Low ratio of saturated to unsaturated fatty acids : LCT x GBD> COD x WCT> WCT x COD> LCT x COD> MYD x WCT> WCT > FMST> FIJT> PHOT> WCT x GBD = ZANT> BENT = JVT> SSGT = WAT> SRNT> LCT> ADOT.
2. High MCFAs : ADOT> LCT> COD x WCT> LCT x COD = FIJT> LCT x GBD> SRNT> SSGT> WCT x COD> WAT> JVT> ZANT> PHOT> WCT x GBD> BENT> WCT> MYD x WCT> FMST.
3. Low ratio of saturated to unsaturated fatty acids and high MCFAs : LCT x GBD> COD x WCT = LCT x COD> FIJT> WCT x COD> SSGT> LCT = ADOT> SRNT> MYD x WCT = ZANT = JVT> WCT = PHOT> BENT = WAT> FMST> WCT x GBD.
4. Low saturated and unsaturated fatty acid ratio + high lauric acid

concentration : LCT x GBD> COD x WCT = LCT x COD> FIJT> WCT x COD> SSGT> LCT = ADOT> SRNT> MYD x WCT = ZANT = JVT> WCT = PHOT> BENT = WAT> FMST> WCT x GBD.

5. High concentration of 6-10 C fatty acids : ADOT> COD x WCT> WCT x COD> SRNT> LCT> LCT x COD> LCT x GBD> FIJT> WAT> SSGT> WCT = WCT x COD> JVT = FMST = PHOT> ZANT> BENT = MYD x WCT.

6. High lauric acid content : ADOT = SSGT>LCT> FIJT> LCT x GBD> LCT x COD> SRNT> COD x WCT> JVT> ZANT> WCT x COD> BENT> PHOT> MYD x WCT> WCT x GBD> WAT> WCT> FMST.

7. Combination of all the traits mentioned above : COD x WCT> LCT x GBD> LCT x COD> ADOT> FIJT> WCT x COD> LCT> SSGT> SRNT> JVT> ZANT> WAT> PHOT> WCT> WCT x GBD> BENT> FMST> MYD x WCT.

From the foregoing it is clear that the best two or three cultivars can be selected for the specified industrial applications. For instance the first group offers the scope of three hybrids for selection for edible purposes, whereas for soap industry the top two or three cultivars in group 4 are promising. Like wise, groups 4 and 6 have suitable cultivars for pharmaceutical purposes.

The study has thus brought out clearly the extent of genotypic variability in the fatty acid composition of coconut oil and the possibility of exploitation of suitable cultivars for different industrial ventures. Since the quality of the end product would depend on the source material used, the present report highlights the availability of appropriate cultivars and signifies the industrial application of the results obtained from this type of basic study. The results indicate the presence of variability in germplasm for fatty acid composition and thus breeding for oil quality is possible.

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Table 1 : The ranking of coconut cultivars based on various criteria

Cultivar	Rank for					
	Low ratio of saturated /unsaturated fatty acids	High MCFAs	Low sat/unsat FAs + high MCFAs	Low sat/ unsat FAs + high lauric acid content	High cocn. of 6-10 C FAs	High lauric acid content
A. Local Talls						
WCT	6	15	8	9	11	16
LCT	14	2	6	6	5	2
ADOT	15	1	6a	6a	1	1
BENT	11	14	11	10	16	11
B. Released and Promising Hybrids						
COD x WCT	2	3	1	2	2	7
WCT x COD	3	8	4	4	3	10
LCT x COD	4	4	3	2a	6	5
LCT x GBD	1	5	2	1	7	4
MYD x WCT	5	16	8a	8	17	13
WCT x GBD	10	13	9	12	13	14
C. Geographically distinct Cultivars						
FIJT	8	4	5	3	8	3
PHOT	9	12	8b	9a	14	12
SSGT	12	7	7	5	10	1a
SNRT	13	6	7a	7	4	6
WAT	12a	9	8c	10a	9	15
ZANT	10a	11	8d	8a	15	9
JVT	11a	10	8e	8b	12	8
FMST	7	17	10	11	13	17