A C T A A L I M E N T A R I A P O L O N I C A
Vol. XII (XXXVI), No. 1 1986

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ACIDITY OF COCOA FAT AS A FUNCTION OF RAW COCOA BEAN QUALITY AND CONDITIONS OF BEAN PROCESSING

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Key words: raw cocoa beans, bruised beans, cocoa pulp, acidity of cocoa fat.

It was found that bean humidity as well as the combined effect of mouldiness, share of small and violet beans, and fermentation coefficient have considerable bearing on the acidity of fat. During the processing of cocoa beans the acidity of fat changes, and the direction of these changes depends on the processing stage.

INTRODUCTION

According to the literature, the acidity of cocoa fat depends on numerous factors including the provenience of the beans [9, 15], the degree of their fermentation, time and conditions of storage [4]. An exceptionally pronounced effect on cocoa fat composition and on free fatty acid content is due to the infection of beans with fungi [6, 7]. From among other factors affecting cocoa fat acidity one can mention the conditions of the technological processing of cocoa beans [10-13, 17] which include also elevated temperature [3, 4]. However, the available literature contains no data which would univocally define the importance of the various factors as well as their effect on cocoa fat acidity.

Our studies were intended to determine the degree to which the level of cocoa fat acidity is affected by the quality of raw beans, as well as to examine whether the fat acidity changes during the processing of beans into nib beans and cocoa pulp.

MATERIAL AND METHODS

The studies were performed with raw cocoa beans from Brasil (Bahia good fermented); 34 batches of these beans were stored and processed at the Confectionery Plant "Gryf" (Szczecin) in the years 1982-1984. The following was determined in the beans: humidity, fat content, quality features determining the bean quality class and those demanded by the cutting test, fermentation coefficient and fat acidity.

The effect of the technological process was determined on the basis of the study of acidity of fat contained in raw beans, in nib beans and in cocoa pulp (in 34 batches of each material).

The qualitative features of raw beans were determined with the use of the cutting test [8, 16]. In order to determine humidity, the fermentation coefficient, the content of fat and fat acidity, the beans were hulled manually and then ground in a ZBPP "Spoiem" laboratory grinder. The humidity of the nucleus was determined by the drier method [16], fat content refractometrically [14] and the coefficient of fermentation according to Gurieva et al. [5]. The acidity of the fat in raw beans, nib beans and cocoa pulp was determined by the benzene method [1]. The presented results are arithmetical means from three parallel repetitions. The results of the acidity of fat in cocoa beans and in the products of their processing were estimated statistically with Student's t test [2]. The part of the calculations concerning the quality of raw cocoa beans was performed on a MERA-400 computer according to the ZEN program.*)

RESULTS AND DISCUSSION

According to ISO international requirements, cocoa beans should be free from insects, broken beans, fragments and pieces of shell, and their humidity should not exceed 7.5%. All the studied batches of raw beans satisfied these requirements (Table 1).

The division of cocoa beans into quality classes is done according to the content of defective beans. The studied batches qualified for class I as regards the content of slaty beans, beans infected with insects, as well as flat and sprouting beans, but failed to meet the requirements of this class concerning internal moulding. In the studied population 8.5% of samples failed to qualify for class II, 11.4% samples qualified for class II, while 80.1% of bean samples exhibited a level of internal moulding qualifying them to quality class I.

*) The authors would like to thank Assistant Professor Z. Woźniak (Department of the Applications of Mathematics and Computer Sciences, Agricultural Academy, Szczecin) for performing the statistical calculations.

The fermentation of beans is indicated by the content of violet beans and by the fermentation coefficient. The degree of beans fermentation is proper when the value of the coefficient of fermentation exceeds unity. Among the studied batches of raw beans, 31.4% had a fermentation coefficient of less than unity; the mean content of violet beans was 6.88% (Table 1).

Table 1. Quality features of 34 examined batches of raw cocoa beans

Specification	Range of values	Mean	Standard deviation	Coefficient of variability
Humidity (%)	3.15-6.80	5.56	0.83	15.02
Fat in dry substance (%)	51.92-56.80	54.95	—	—
Mass of 100 beans (g)	97.90-119.90	108.14	—	—
Scraps (%)	0.26-4.20	2.03	—	—
Cocoa shell (%)	12.30-16.90	13.96	—	—
Beans of mass less than 1 g (%)	4.00-25.20	13.47	5.21	38.70
Beans internally mouldy (%)	0.00-5.30	1.63	1.43	87.98
Beans mechanically damaged (%)	0.45-4.00	1.80	—	—
Flat beans (%)	0.00-1.30	0.21	—	—
Slaty beans (%)	0.00-2.14	0.26	—	—
Violet beans (%)	1.30-16.70	6.88	3.78	54.94
Coefficient of fermentation	0.72-1.25	1.02	0.13	13.20
Acidity of fat in convertion to oleic acid (%)	0.57-1.75	1.04	0.30	28.85

The studied beans were relatively finely grown, since in 74.3% of the batches the weight of 100 beans ranged from 100 to 110 g, while in 22.8% the figure was as high as 110-120 g.

Fat acidity in the investigated raw beans batches ranged from 0.55 to 1.75% oleic acid. The acidity of fat in cocoa beans changes as a result of glicerides hydrolysis. This process may be enhanced, among others, by: the humidity, the mouldiness and the degree of fermentation of the beans. From the technological viewpoint, an increased content of small beans in a batch is also unfavourable. Bearing this in mind, we studied the corelation between the acidity of cocoa fat and bean humidity, the content of small, of internally mouldy and of violet beans, and the coefficient of fermentation.

The following regression coefficients were obtained in the experiment conditions:

humidity of beans	$B = 0.1609$,	$T = 2.527$
content of internally moulded beans	$B = -0.0009$,	$T = -0.024$
content of small beans	$B = 0.0028$,	$T = 0.247$

content of violet beans	B = −0.0424,	T = −0.268
coefficient of fermentation	B = 0.2566,	T = 0.621
acidity of fat	B = −0.1207	

Basing on the obtained results it was found that at fixed (but statistically insignificant) effect of internal moulding, of the contents of small and violet beans and of the fermentation coefficient, the regression function (Fig. 1) representing the dependence between the acidity of cocoa fat and the qualitative features of beans takes the form (partial regression):

$$y = 0.17\,x + 0.15$$

where x is the humidity of raw cocoa beans.

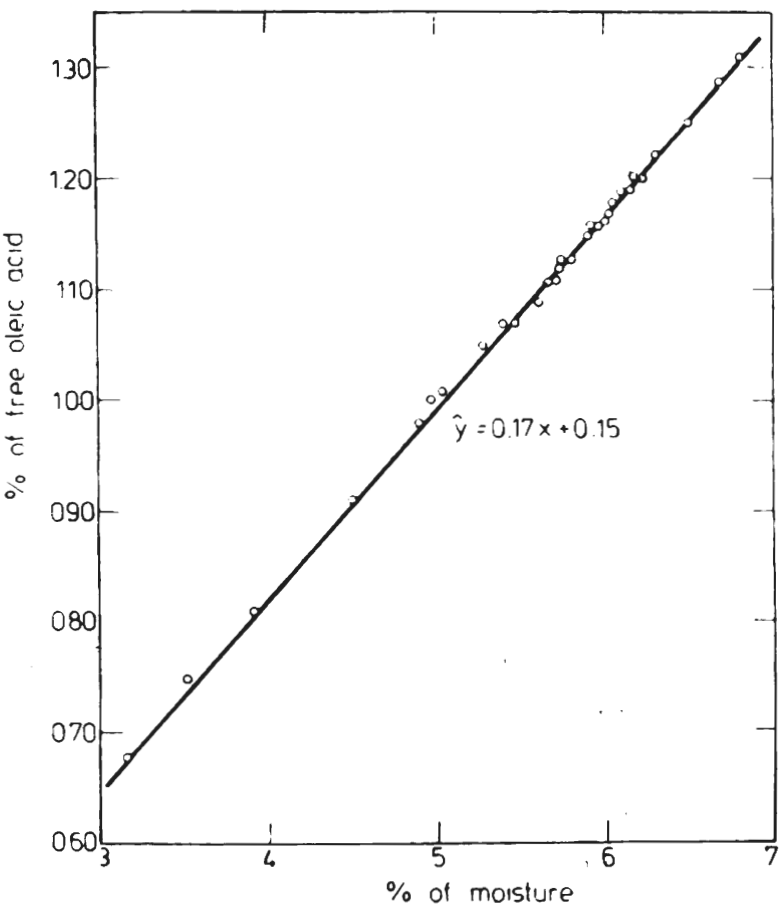

Fig. 1. Relation between bean moisture and acidity of cocoa fat

The coefficient of multiple regression R = 0.493. The regression coefficient 0.17 has the Student test equal 2.527, while the critical value $t_{\alpha} = 0.05 = 2.048$, and thus it is statistically significant. It proves the statistical significance of the combined effect of the studied qualitative properties of raw beans on the level of acidity of the fat contained in those beans.

The changes of fat acidity in the separate stages of cocoa beans processing were studied next. The mean acidity of fat in the raw beans used in this series of experiments was 0.84% oleic acid (Table 2). After roasting the mean acidity of fat in nib beans dropped to 0.67% oleic acid, to rise again to a level close to that in raw beans during the deoiling

Table 2. Basic qualitative properties of raw beans and semi-finished products at several stages of cocoa bean processing

Product	Number of experiments	Humidity (%)	Fat in dry substance (%)	Acidity of fat (% of oleic acid)		
				range of values, mean ($\bar{x}$)	standard deviation	coefficient of variability
Raw beans	34	3.15-6.80 $\bar{x}$ = 5.46	51.92-57.87 $\bar{x}$ = 55.18	0.26-1.75 $\bar{x}$ = :0.84	0.06	7.14
Nib beans	34	1.00-3.73 $\bar{x}$ = 2.15	47.86-56.81 $\bar{x}$ = 54.32	0.41-0.88 $\bar{x}$ = 0.67	0.02	2.98
Cocoa pulp	34	1.02-3.06 $\bar{x}$ = 2.18	50.73-58.48 $\bar{x}$ = 53.76	0.54-1.29 $\bar{x}$ = 0.86	0.03	3.48

Interdependences between acidities of fat in:
raw beans and nib beans (t) = 2.83
nib beans and cocoa pulp (t) = 4.75
raw beans and cocoa pulp (t) = 0.29
critical value t = 0.05 = 1.97

of cocoa pulp. Statistical calculations showed that at the significance level $\alpha = 0.05$ there are statistically significant differences in fat acidity between raw beans and nib beans, as well as between nib beans and cocoa pulp, indicating that this feature of fat undergoes changes during the roasting of beans and during deoiling of cocoa pulp. These changes may be due to the high temperature applied during the roasting of raw beans and heating of cocoa pulp. Levanon et al. [13] report that new fractions of fatty components appear during processing of cocoa beans this being confirmed by the higher content of free fatty acids in cocoa butter as compared to this content in fat extracted from cocoa beans by Soxhlet's method. The extent of fat acidity changes as well as their direction depend on the quality of raw cocoa beans, and in particular on the humidity of the beans and of semi-finished products obtained from them. When these products are highly humid, the heat treatment involves harsher conditions or an extended action of elevated temperature and affects the level of acidity of the fat in these products.

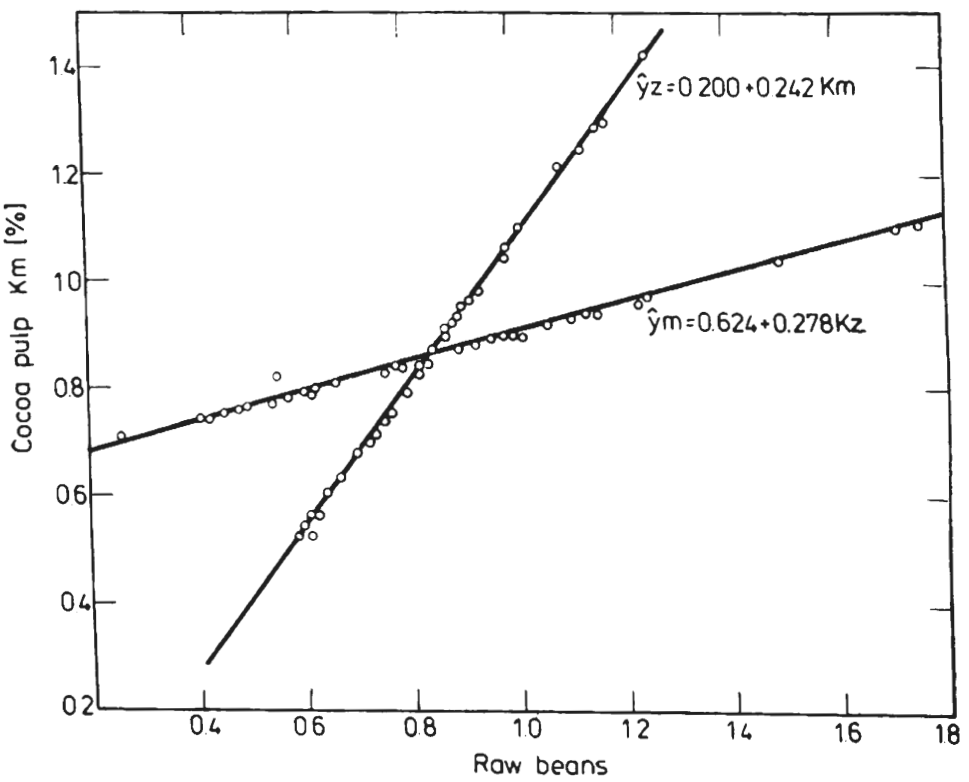

Fig. 2. Interdependence between fat acidity in raw beans and in cocoa pulp; K_m — fat acidity in cocoa pulp, K_z — fat acidity in raw beans

At the stage of pulp deoiling, the changes in fat acidity go in the direction of the mean level of acidity found in raw beans. This tendency is indicated by the lack of statistically significant differences in mean fat acidity between raw beans and cocoa pulp (Table 2). The calculated coefficients of regression (Fig. 2) show that the acidity of fat in the pulp increases by 0.278% per unit of acidity of fat contained in raw beans.

CONCLUSIONS

1. Separate batches of raw cocoa grain differ as regards fat acidity. A statistically significant effect on this acidity is due to bean humidity and such qualitative properties as degree of fermentation, mouldiness and content of small beans (acting jointly).

2. During the processing of raw cocoa beans, the fat acidity changes and the direction and extent of these changes depend on the stage of processing and quality of the product.

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Manuscript received: August, 1984
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KWASOWOŚĆ TŁUSZCZU KAKAOWEGO JAKO FUNKCJA JAKOSCI ZIARNA I WARUNKÓW JEGO PRZEROBU

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Streszczenie

Badano jakość surowego ziarna kakaowego (34 partie) pochodzącego z PPC „Gryf" w Szczecinie oraz wpływ wybranych cech jakościowych tego ziarna (wilgotność, udziały ziarn zapleśniałych wewnętrznie, drobnych i fioletowych, współczynnik przefermentowania) na kwasowość tłuszczu kakaowego. Kwasowość tłuszczu w badanym ziarnie kakaowym znajdowała się w przedziale 0,57-1,75% kwasu oleinowego, natomiast średnie wartości dla analizowanych cech jakościowych wynosiły: wilgotność 5,56%, udział ziarn drobnych 13,47%, zapleśniałych wewnętrznie 1,63%, fioletowych 6,88% i współczynnik przefermentowania 1,02. Wyniki badań wykazały, że na kwasowość tłuszczu w surowym ziarnie kakaowym statystycznie istotny wpływ wywiera wilgotność oraz łącznie pozostałe cechy jakościowe. Zależności te obrazuje funkcja regresji: $y = 0{,}17\,x + 0{,}15$, w której: y — kwasowość tłuszczu, x — wilgotność ziarna surowego.

W trakcie przerobu ziarna kakaowego kwasowość tłuszczu w uzyskiwanych półproduktach zmienia się, co potwierdzają statystycznie istotne różnice przy poziomie istotności $\alpha = 0{,}05$ między kwasowościami tłuszczu w ziarnie surowym i śrucie kakaowej oraz w śrucie i miazdze. Na etapie zolejania miazgi kakaowej zmiany kwasowości zmierzają do zbliżenia się do średniego poziomu, stwierdzonego w ziarnie surowym. O tendencji takiej świadczy brak statystycznie istotnych różnic w średniej kwasowości tłuszczu między ziarnem surowym i miazgą.