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Studies on cocoa butter-replacer mixtures suitable for the local chocolate production

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RESUMEN

Estudios sobre mezclas manteca de cacao/sucedáneo adecuadas para la producción de chocolate local.

Se prepararon mezclas de manteca de cacao con diferentes sucedáneos añadidos en diferentes proporciones. Sus propiedades y particularmente el índice de grasa sólida, ayudaron mucho en la selección de la mezcla más adecuada para la producción de chocolate local. Se encontró que las mezclas con el 10% o 15% de Illexao en manteca de cacao, dieron los resultados más satisfactorios con respecto a la palatabilidad, dureza y consistencia.

PALABRAS-CLAVE: Chocolate — Indice de grasa sólida — Mezcla manteca de cacao — sucedáneo.

SUMMARY

Studies on cocoa butter-replacer mixtures suitable for the local chocolate production.

Mixtures of cocoa butter with different replacers, added at different levels, were prepared. From their properties, and particularly solid fat index, helped much in selecting the more suitable mixture for local chocolate production. It was found that cocoa butter-Illexao mixtures, at levels 10% and 15% replacer, gave more satisfactory results with respect to mouthfeel, hardness and brittleness.

KEY-WORDS: Chocolate — Cocoa butter - replacer mixture — Solid fat index.

1. INTRODUCTION

Cocoa butter is essentially the natural fat of the cocoa bean, but definitions in some countries limit it to the natural fat obtained from well winnowed cocoa nib by hydraulic or expeller pressing (Minifie, 1980). Cocoa butter, which contributes 30-40% by weight to finished chocolate, provides the desired texture, mouthfeel, and flavor release properties. Variation in cocoa butter composition can result in unacceptable physical properties (Lees and Jackson, 1980; Chaiseri, and Dimick, 1989; Arruda and Dimick, 1989; Chaiseri and Dimick, 1995 $_{a, b}$). In chocolate manufacturing, careful control of the solidification processes is quite important because it significantly influences both rheological properties of chocolate which determine the workability in the production processes and physical properties of end product such as gloss, snap, texture, heat resistance, fat bloom stability,... etc. The physical properties are related to polymorphism of cocoa butter, which comprises the major solid fat in chocolate (Chaseri and Dimick, 1995 $_{b}$; Reddy *et al.,* 1996; Malssen *et al.,* 1996 $_{a}$). At present, every one agrees that composition of cocoa butter influences its physical and chemical properties (Chaiseri and Dimick, 1989; Malssen *et al.*, 1996 $_{a, b}$).

Cocoa butter, is an important and expensive ingredient in chocolate. Therefore, it is planned to prepare mixtures of cocoa butter with some substitutes at different weight ratios to select the most suitable one for chocolate production. Evaluation is mainly based on physical and chemical properties with emphasis on solid fat index (SFI). The substitutes that have selected include Cebes, Illexao and Nchox representing lauric and non-lauric acid substitutes.

2. MATERIAL AND METHODS

Materials

Cocoa butter and replacers, namely Cebes 30-80, Illexao 30-92 and Nchox 335 were supplied by ICA Factory of Egyptian Company for Foods, season 1996. These replacers are originally manufacturated in Malaysia by Aarhus Dliefabrik A/S and Premium Vegetable Oils SDN BHD Company. All solvents and chemicals are high purity grade of BDH (England) and MERCK (Germany).

Methods

Solid fat index (SFI) was determined according to IUPAC method (1972) using Nuclear Magnetic Resonance (NMR) Spectrometer Model/Bruker

PC/C (Minispec). SFI was measured at 5, 10, 15, 20, 25, 30, 35, 40 and 45°C. Melting point (MP), refractive index (RI), iodine value (IV), saponification value (SV) and nonsaponifiable fraction (NSF) were determined according to the methods of A.O.C.S. (1985). All the results are the mean of two concordant and promising values.

3. RESULTS AND DISCUSSION

Melting point (MP), refractive index (RI), iodine value (IV), saponification value (SV) and nosaponifiable fraction (NSF) for natural cocoa butter and replacers as well as their mixtures are recorded in Table I. With reference to the MP, cocoa butter shows MP of 31.0°C, however the replacers namely Cebes, Illexao and Nchox have MP of 35.5°C, 36.0°C and 36.0°C, respectively. By using replacers at levels of 5%, 10% and 15% of the weight of cocoa butter, it was noticed that the MP of the mixtures markedly decreases. This decrease in MP can be due to the low MP of cocoa butter used as the main component of the mixtures (Minifie, 1980; Malssen et al., 1996 $_b$). It is expected that this MP can be increased by pretreatment (tempering) during the processing and the production of chocolate. These changes can probably be due to the polymorphic forms of mixtures (Minifie, 1980; Lees and Jackson, 1980). Thus, increasing in MP is more desirable as quality criterion of the final product. It worthy to mention that low IV are exhibited by lauric acid replacers (Cebes and Nchox).

Table I
Chemical and physical properties of cocoa butter and its mixtures with different lauric and non-lauric replacers

Constituents		M.P. (°C)	R.I.	I.V.	S.V.	N.S.F. (%)
Cocoa butter		31.0	1.4560	35.53	197.75	1.27
Cebes **		35.5	1.4440	4.91	241.23	1.01
Illexao *		36.0	1.4480	42.51	190.74	1.19
Nchox **		36.0	1.4412	11.42	267.87	1.09
Cebes						
	5%	30.5	1.4547	34.26	204.76	1.20
	10%	33.0	1.4517	34.26	206.17	1.18
	15%	33.5	1.4485	33.63	208.97	1.10
Illexao						
	5%	31.5	1.4560	35.53	197.75	1.27
	10%	30.5	1.4532	36.17	197.75	1.27
	15%	30.0	1.4517	37.43	196.35	1.13
Nchox						
	5%	30.5	1.4530	34.89	206.17	1.25
	10%	32.5	1.4495	34.26	210.37	1.20
	15%	32.0	1.4477	33.63	214.58	1.18

* Lauric replacer.
** Non-lauric replacer.

Solid fat index (SFI) for natural cocoa butter and replacers as well as their mixtures are recorded in Table II and are illustrated in Figures 1-4. In the frame of quality parameters, it is of interest to deal with the solid content at different temperatures. It is known that SFI of cocoa butter shows lower solid content (28.7% and 2.05%) at range of 25-30°C and 0.95% at 35°C. With reference to these changes in the three types of replacers (Cebes, Illexao and Nchox), it can be noticed that there are marked variations in SFI at the above mentioned temperature ranges (Minifie, 1980; Croklaan, 1980). Cebes exhibits SFI value of 94.93%, 90.95% and 60.43% at 20°C, 25°C and 30°C, respectively whereas, Nchox gives nearly similar values at the same temperatures. However, Illexao give 69.77%, 59.74% and 40.96% at 20°C, 25°C and 30°C, respectively.

Dealing with the mixtures of Cebes replacers with cocoa butter at levels of 5%, 10% and 15%, it can be seen that only 5% gives a high SFI at 20°C, 25°C and 30°C (61.02%, 21,73% and 6.11%). Meanwhile the 10% substitution of cocoa butter by Cebes gives 53.78%, 16.39% and 4.80% corresponding to 49.81%, 11.14% and 4.10% when substituting cocoa butter with 15% Cebes. It seems that the higher SFI can be obtained when substituting cocoa butter at a level of 5% of Cebes. When substituting cocoa butter with 5%, 10% and 15% of its weight with Nchox, there is a decrease in SFI particularly at 20°C at 25°C,whereas the SFI is keept nearly constant at 30°C. Thus, SFI at 20°C decreases to 60.84%, 54.93% and 51.05% by substituting the cocoa butter with 5%, 10% and 15% of Nchox, respectively. On the other side, the SFI content at 25°C corresponds to 21.54%, 15.64% and 12.73%. It is apparent that there is a gradual decrease of SFI at different temperatures when increasing the levels of replacers namely Cebes and Nchox. This may be due to the possibility that Cebes and Nchox are lauric acid replacers and therefore they affect the SFI in a similar manner when replacing cocoa butter (Croklaan, 1980; Sridhar *et al.,* 1991).

Illexao, being non-lauric cocoa butter replacer, gives SFI approximating to that of cocoa butter when it substitutes the latter with different concentrations. Therefore, SFI is two-fold the value of cocoa butter at 30°C. From these results, it can be noticed that Illexao is more suitable as a replacer for cocoa butter particularly at 10% and 15% levels.

With reference to the SFI that is more suitable for chocolate production in hot weather countries, it can be concluded that cocoa butter-Illexao mixtures are more suitable than mixtures with Cebes and Nchox, since the latter two substitutes tend to lower SFI at 20°C and 25°C.

Table II

Solid fat index (SFI) of cocoa butter and its mixtures with different lauric and non-lauric replacers

Constituents		5°C	10°C	15°C	20°C	25°C	30°C	35°C	40°C	45°C
Cocoa butter		95.24	92.79	84.11	69.26	28.70	2.05	0.95	0.00	0.00
Cebes **		99.42	99.34	96.88	94.93	90.95	60.43	1.75	0.00	0.00
Illexao *		81.26	79.25	75.48	69.77	59.74	40.96	18.69	1.21	0.00
Nchox **		99.36	99.17	96.48	95.21	87.90	56.90	4.44	0.90	0.00
Cebes										
	5%	95.33	91.21	80.67	61.02	21.73	6.11	0.78	0.00	0.00
	10%	95.72	92.24	83.46	53.78	16.39	4.80	1.34	0.00	0.00
	15%	96.23	92.47	82.81	49.81	11.14	4.10	0.42	0.00	0.00
Illexao										
	5%	93.90	92.11	84.65	68.81	30.58	3.30	1.19	0.00	0.00
	10%	92.98	91.69	82.71	69.78	33.16	4.46	1.02	0.00	0.00
	15%	91.29	90.99	85.40	68.00	33.17	4.42	1.12	0.00	0.00
Nchox										
	5%	94.93	91.54	83.35	60.84	21.54	4.43	1.15	0.00	0.00
	10%	95.37	91.72	82.50	54.93	15.64	4.50	0.92	0.00	0.00
	15%	96.21	92.89	83.72	51.05	12.73	4.36	0.31	0.00	0.00

* Lauric replacer.
** Non-lauric replacer.

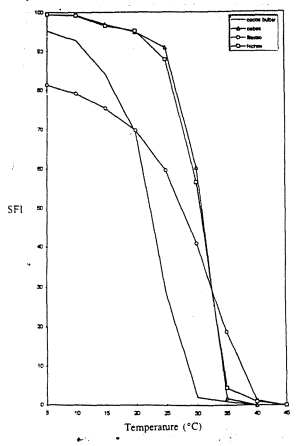

Figure 1

Solid fat index (SFI) of cocoa butter compared with some cocoa butter replacers at different temperatures.

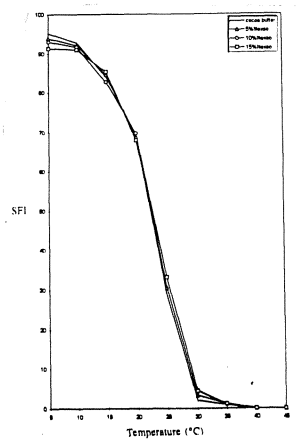

Figure 3

Solid fat index (SFI) of cocoa butter as affected by addition of Illexao at different temperatures

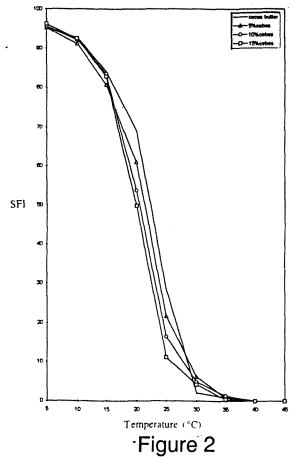

Figure 2

Solid fat index (SFI) of cocoa butter as affected by addition of Cebes at different temperatures.

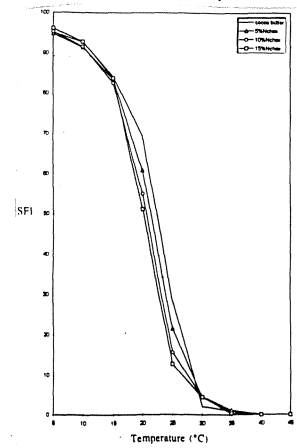

Figure 4

Solid fat index (SFI) of cocoa butter as affected by addition of Nchox at different temperatures.

It is worthy to mention that high solid content acquires the chocolate product both hardness and brittleness at room temperature (Minifie, 1980; Lees and Jackson, 1980). On the other side, cocoa butter-Illexao mixtures show very lower SFI values at 35°C indicating that the total solids are nearly negligable at nearly the body temperature. It was reported that the absence of solids at body temperature, combined with the short melting range, indicates a pleasant mouthfeel (Croklaan, 1980).

Comparing SFI values at 20°C, 25°C and 35°C for cocoa butter-Illexao mixtures, it is observed that similar values are obtained. This confirms the view that cocoa butter-Illexao mixtures are more feasible in chocolate production in hot weather countries, moreover better mouthfeel and physical properties are obtained (Minifie, 1980; Lees and Jackson, 1980; Croklaan, 1980).

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