Studies on Preparation and Physico-chemical Properties of Chocolate from Indigenous Cacao Beans

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Abstract

Chocolate is remarkably stable material which under normal conditions will keep indefinitely and this in conjunction with a high nutritive value makes it valuable not only as a confection but also for emergency rations. In this research, preparation of cocoa powder from indigenous cacao beans were made by fermentation, drying, roasting and grinding. Fermentation was done under various fermentation time by heaping the beans and covering them with leaves. Fermented cacao beans were dehydrated (or) dried by two drying methods; sun-drying and artificial drying (Dryer). The dried beans were roasted to further developed flavor and color. Physico-chemical properties of cacao beans were studied after fermentation, drying, roasting and grinding. The sample nibs were analyzed for moisture, ash, fat, fiber, protein, tannins. Results of them were compared with literature values. After making chocolates from indigenous cacao beans, physico-chemical properties of the chocolate were compared with commercial chocolate.

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Introduction

Chocolate and related products begin with cacao beans. The cacao bean, the seed of theobroma cacao, is a tropical crop. Theobroma cacao received its name by Linnaeus, a Swedish botanist, in *1753* in the first addition of "Species Plantarum". It belongs to the botanical family *Sterculiaceae* (Dimick 1993). Botanically, there are two main groups, the purple seeded Forastero which supplies most of the world's cocoa, and the white seeded Criollo, a less abundant type which produces a mild flavored high quality cocoa. Both cocoa and chocolate are extracted from the seeds, or cacao beans, of the theobroma cacao trees, native to South and Central America. The bean after separation from the pods are to be fermented by microbiologically and enzymatically for removing the pulp or mucilage covering of the beans and to increase the flavour of the beans. Drying of cacao beans is to reduce moisture content to a level that is safe for bean storage and shipment without adversely affecting the bean quality. The range of temperature required for drying the beans are 45˚C to 60˚C. The beans are sun-dried or machine-dried to about 7% moisture to give them good keeping quality (Dimick 1993). Dried cacao beans is roasted in order to develop the characteristic aroma and flavor of chocolate and to drive out unpleasant volatile substances. At the same time, the nib is dried and the shell loosened. Roasted nibs were ground to a very fine powder in a grinder. Ground roasted beans and sugar were added to the cocoa butter to produce dark "eating (solid)" chocolate. Milk chocolate. made with the addition of dried milk solids was developed by Swiss in about 1876. Cocoa powder and cocoa butter are the basic ingredients in chocolate and chocolate products. There are many types of chocolate that differ in the amounts of cocoa powder, cocoa butter, sugar, milk and other ingredients they contain.

Materials and Methods

Materials

Indigenous cacao beans (the purple seeded Forastero) were collected from Natmauk Road, Myaypadaytha Kyun, Bahan, Yangon. Myanmar and were prepared for cocoa powder in laboratory by fermentation, drying, roasting and grinding. Sugar, commercial milk fat, milk powder were purchased from a local supermarket. Chocolate and related products begin with cacao beans, which grow in elongated melon-shaped seed pods attached to the theobroma cacao tree is shown in Figure (1).

Methods

Fermentation of Cacao Beans

The freshly harvested cacao pods were stored for ten days under shady place and fermented for five days with single turning after 48 hours Figure (2). Three samples of cacao beans were prepared from various fermentation times. Sample (1) was fermented for 2 days, sample (2) was fermented for 5-10 days and sample (3) was fermented for over 10 days. The samples are shown in Figure (3) and their physical properties are shown in Table (1).

Drying of Fermented Cacao Beans

The fermented cacao beans were dehydrated/ dried by two drying methods: sun-drying, artificial drying (dryer). The purpose of drying operation was to determine the characteristics of cacao beans related to moisture content, drying rate under various condition (sun-drying and dryer). The drying rates of fully fermented cacao beans for different methods were determined and the results are shown in Table (2) and (3).

Roasting of Fermented, Dried Cacao Beans

Roasting was carried out in a pan, which is directly heated and stirred. The brittle roasted beans were cracked and fragments were blown with air to separate the shell and nib by using fan. The moisture content, ash content, fat, crude fiber, protein and tannins contents of roasted nibs were determined and their relevant data are tabulated in Table (4).

Preparation of Cacoa Powder

Roasted nibs were ground to a very fine powder in a grinder. The mixture from the grinder were sieved by using 140 mesh and 200 mesh screens. Three samples of cocoa powder were prepared i.e. under fermented (sample 4), fully fermented (sample 5) and over fermented cocoa powder (sample 6) as shown in Figure (4). Sensory evaluation of cocoa powder were studied by organoleptic tests and the results are shown in Table (5).

Preparation of Milk Chocolate

Milk chocolate was prepared from 10 g of fully fermented cocoa powder, 30 g sugar, 15g milk powder and 15g of milk fat. Cocoa powder and crystal sugar were mixed in the pan and grinding. The mixture from the grinder were mixed with the milk powder and milk fat (cocoa butter substitute) to produce a homogeneous paste. The mixture may contain quite coarse particles and they were reduced in size by passing the paste through the refining rolls where it is ground to give a smooth texture.

Chocolate was next conched or kneaded in mixing pan to develop increase smoothness, viscosity and flavor. Conching was done at about 60˚C for three hours. Conching is not essential to chocolate manufacture but is rarely omitted in producing a high quality product. Tempering of chocolate was done by hand, in which one-third of the chocolate at about 60˚C was cooled by spreading it on a cold surface. The solidified chocolate was then scraped off and mixed with the rest liquid chocolate. The final temperature of the chocolate was controlled at 32˚C. A simple methods to determine tempering chocolate was determined as follows. A metal spatula was taken (or knife blade) and dipped it in the chocolate that was hopefully in tempered and left only a thin film. Then the spatula was placed in cool room (18-21˚C). The time required was observed for the chocolate to harden to the touch (Set-up timing). Set-up timings were determined as follows:

(website: www. admworld. com)

<2 minutes- Over tempered; may have less than optimal gloss

4-6 minutes- Good temper; good gloss

7-9 minutes- May still have a soft texture; under tempered; good

gloss; may bloom in 1-2 months.

>10 minutes- little or no temper; poor gloss; presence of bloom.

The processes used for producing finished chocolate was moulding and covering. For moulding, the chocolate was cooled from the temperature at which it was liquid until it solidifies. After moulding, 50 g of chocolate was obtained for each

batch. The chocolate was kept in the freezer under the temperature 18˚C for further experiments. The physico-chemical properties of chocolate and other imported chocolate were determined. The flavour, smoothness of chocolate were determined by organoleptic tests and compared with imported chocolate and the results are shown in Tables (6) and (7).

Results and Discussion

The important operations before preparing cocoa powder are pod storage period, fermentation, drying and roasting. Result in Table (1) showed that under fermented dried cacao beans (fermented for two days, sample 1) were dense cheesy texture purple in colour and vary between these extremes. Fully fermented cacao beans (fermented for 5-10 days, sample 2) were brown and friable with spaces between the cotyledons while over fermented cacao beans (fermented for over 10 days, sample 3) gave a chocolate lacking in flavour.

Results in Table (2) and (3) showed drying time of fermented cacao beans was short in dryer. However, the quality of the products of continuous drying at a temperature of 45˚C and sun drying at 40˚C were not much different. It was also found that the moisture content could be reduced to 8% by natural sun drying during rainy season while moisture content could be reduced to 7% by continuous drying. Table (3) showed that drying by dryer was agreement with Dimick (1993) who found that 7% moisture content of dried cacao beans gave them good keeping quality.

Roasting is essential to generate the flavor compounds arise from precursors developed during fermentation and drying of cacao beans. A comparative study of the initial chemical characteristics of the roasted ground nibs with those of literature value were done. The roasted ground nibs were analyzed for moisture, ash, fat, fiber, protein, tannins and results were shown in Table (4). The moisture %, ash %, fat %, fiber % protein % and tannins % were found to be comparable to the literature value.

Results in Table (5) indicated that sample (4) gave rise to a harsh astringent flavour due to the acetic acid produced during fermentation which imparts a harsh flavour and taste, mask-off the cocoa flavour in the final manufacture products. Sample (5) agreed with Keenedy, 1983 who found that a darker, redder cocoa product is associated with a more chocolate-like flavour. Over fermented cocoa powder

(fermented for over 10 days sample (6) gave a chocolate lacking in flavor. In this case, fully fermented cocoa powder (5-10 days fermentation periods) and continuous drying (dryer) was better than the other cases.

Table (6) showed that chemical composition of hand made chocolate and other imported chocolate samples (Figure.5) were not much different. These values can be changed by the presence of additives, wal-nuts, hazel-nuts, almonds, raisins and other dried or candied fruit.

Tempering is an important operation for the preparation of chocolate. The chocolate samples (other imported and laboratory made) were determined by organoleptic tests. Table (7) shows the comparison of the sample and other imported chocolate sample. Having shiny, hard, glossy, finished products of both hand made and other imported chocolate (Table 7) was good indication that chocolate was well tempered.

However, smooth product was not available in hand made chocolate. It could be observed that particle size of the chocolate is most important in the month feel and whether it is perceived as gummy, creamy or gritty. The smoothness of chocolate is most directly assessed by tasting but limitation of such subjective test is obvious and it is usual to use a particle size method to assess the "fineness" of chocolate.

Grinding the roasted beans to a fine pulp is very important as it is the first step in producing an exceptionally smooth product. According to Jensen, a small proportion of particles cocoa exceeding 100 micro meters in diameter may give impression of roughness. In commercial scale chocolate refines a set of rollers, crush the paste into flakes that are significantly reduced in size. This step is critical in determining how smooth chocolate is when eaten.

In this research, for grinding, the roasted cacao beans and refinery of chocolate, only hand driven machine was used 0.105mm (105 micro meters) opening screen was used indicating that particle size of cocoa powder obtained was 0.105mm (105 micro meters). Diameter over 100 micrometers gave an impression of roughness.

It has been observed that there were no colour and flavour difference among the chocolate samples. However chocolate sample perceived gritty mouth feel due to the particle size of cocoa powder it contain because it is difficult to remove cocoa

butter from cocoa powder obtained from our experiments. More modern methods use a series of vertical discs, a series of rollers, or a combination of the two. During the process, the fat cells are ruptured and the heat of friction liquefies the mass. The resulting liquor or cocoa mass be used directly in the melangeur pan, blocked-off for storage or supplied to a hydraulic press for cocoa powder manufacture.

According to the nutritive value of cocoa powder and chocolate, cocoa powder prepared from those operations involved in our experiments could be used as a raw material for chocolate making to substitute imported cocoa powder.

Table (1) Physical Properties of Cacao Beans before and after Fermentation

Sample	Appearance	
	Before Fermentation	After Fermentation
Sample (1) under fermented	purple in colour	dense cheesy texture, purple in colour
Sample (2) fully fermented*	purple in colour	brown, friable with spaces between the cotyledons
Sample (3) over fermented	purple in colour	dark

***** The best condition

Table (2) Calculated Data of Moisture Content and Drying Rate for Fully-Fermented Cacao Beans by Sun-drying

Drying time=9.5 hours

	Sun drying at 40˚C	
Drying Time (hr)	Moisture Content (%w/w)	Drying Rate (g/hr cm^2)
0	70.53	0.2
0.5	63.74	0.2
1	62.29	0.2
1.5	60.95	0.2
2	56.29	0.4
2.5	54.48	0.6
3	49.62	0.2
3.5	45.00	0.4
4	42.61	0.2
4.5	38.89	0.4
5	32.65	1
5.5	29.03	0.4
6	24.14	0.6
6.5	20.48	0.8
7	14.29	0.2
7.5	12.00	0.0
8	9.59	0.0
8.5	8.33	0.0
9	8.33	0.0
9.5	8.33	0.0

Table (3) Calculated Data of Moisture Content and Drying Rate for Fully-Fermented Cacao Beans by Dehumidified Air Dryer

Drying time=6.5 hours

Drying at 45˚C		
Drying Time (hr)	Moisture Content (% w/w)	Drying Rate (g/hr cm^2)
0	68.33	0.2
0.5	65.45	0.2
1	62.00	0.2
1.5	58.69	0.4
2	53.66	0.4
2.5	47.22	0.2
3	40.63	0.2
3.5	32.14	0.2
4	26.92	0.2
4.5	24.00	0.2
5	20.83	0.2
5.5	13.64	0.0
6	9.52	0.0
6.5	7.32	0.0

Table (4) Approximate Composition of Roasted Nibs

	Literature Value * (% w/w)	**Roasted Nibs ** (% w/w)**
Moisture	2	3
Ash	3	3-4
Fat	50-57	50
Fiber	3	3.145
Protein	11	10.5
Tannins	6	7.2277
Alkaloids	1.5	ND***
Carbohydrate	9	ND
N Free extract	8	ND
Organic acid	2.5	ND
Theobromine	1.3	ND
Caffeine	0.7	ND

* From published data (Food Technology Processing and Laboratory Control)

** Data obtained were determined at the Cottage Industries Department

*** Not detected

Table (5) Sensory Evaluation of Cacoa Powder after Roasting and Grinding

Sample	Color	Taste	Odor (The basic cocoa note)
Sample (4) under fermented	dull brown	harsh astringent	slight
Sample (5) fully fermented*	reddish brown	Best (chocolate-like flavour)	slight
Sample (6) over fermented	brown	chocolate lacking in flavour	slight

* The best condition

Table (6) Approximate Composition (100 g) of Milk Chocolate

Component	Tango Badam Made in Malaysia (Sample 4)	Vochelle Made in Malaysia (Sample 5)	Hand made in Laboraory (Sample 6)
Proteins	10 g	9.3 g	7.6 g
Fat	44 g	32.6 g	32.3 g

Table (7) Sensory Evaluation of Milk Chocolate

Sample	Appearance	Color	Odor	Mouth feel and Smoothness (The basis cocoa note)
Sample (7)	gloss	brown	strong	good/smooth
Sample (8)	gloss attractive appearance	brown	strong	good/gritty
Sample (9)	gloss attractive appearance	brown	strong	good/smooth

Sample (7) - Tango Badam Made in Malaysia

Sample (8) - Milk Chocolate Hand Made in Laboratory

Sample (9) - Vochelle Made in Malaysia

Figure 1. Theobroma Cacao Tree

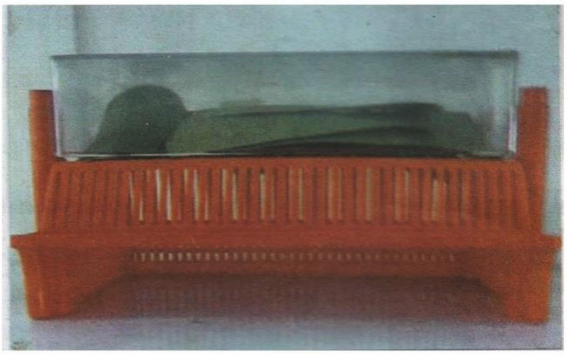


Figure 2. Fermentation of Cacao Beans

Sample (1)

Under Fermented Cacao Beans-

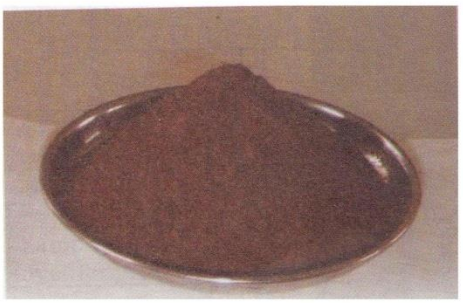
Sample (1)

Sample (2) Sample (3)

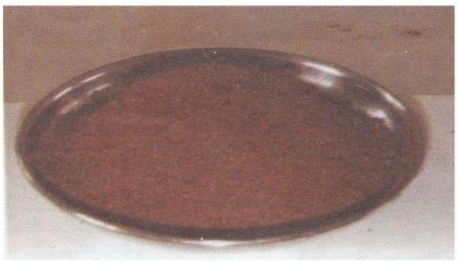
Fully Fermented Cacao Beans-Sample (2) and

Over Fermented Cacao Beans-Sample (3)

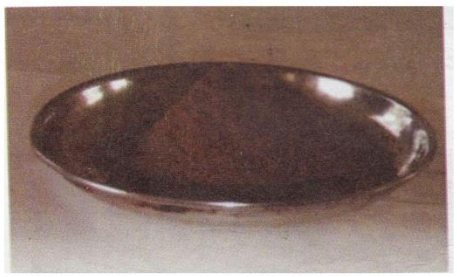
Figure 3. Fermented, Dried Cacao Beans under Various Fermentation Conditions



Sample 4 Under Fermented Cocoa Powder

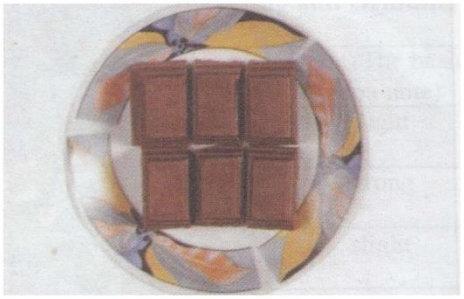


Sample 5 *Fully Fermented Cocoa Powder

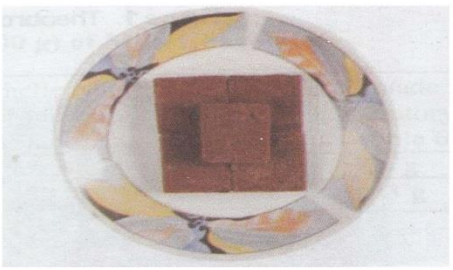


Sample 6 Over Fermented Cocoa Powder

Figure 4. Cocoa Powder Obtained under Various Fermentation Conditions



Sample 7 Tango Badam Milk Chocolate Made in Malaysia



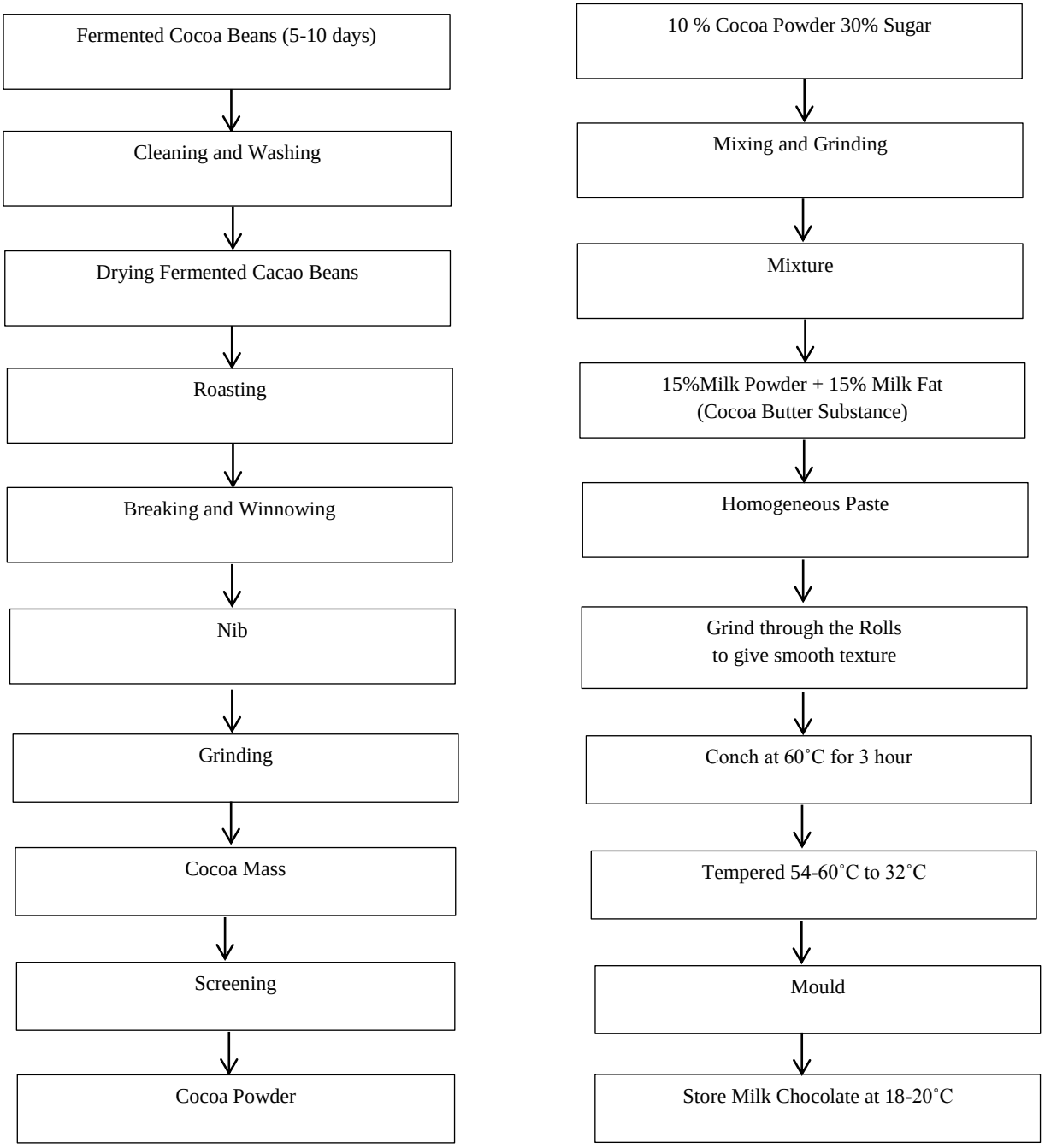
Sample 8 Hand Made Milk Chocolate Made in Laboratory

Sample 9 Vochelle Milk Chocolate Made in Malaysia

Figure 5. Comparison between Imported Chocolae and Hand Made Milk Chocolate

Preparation of Cocoa Powder **Preparation of Milk Chocolate**

Preparation of Cocoa Powder **Preparation of Milk Chocolate**



Flow Diagrams for the Preparation of Cocoa Powder and Milk Chocolate

Conclusion

Eventhough having shiny, hard, glossy, finished chocolated product was obtained, gave an impression of roughness. This result indicated that further studies should be carried out to get the smoothness of chocolate by using a set of rollers (modern refiners) to reduce the particle size of cocoa powder. Modern refiners can yield high quality chocolates in which 90 percent of the particles are less than 20 micrometer.

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