

# PHILIPPINE NATIONAL STANDARD

PNS/BAFS PAES 191:2018  
ICS 65.060.01

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## Agricultural Machinery- Cacao grinder - Methods of Test



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### BUREAU OF PHILIPPINE STANDARDS (BPS)

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## **Foreword**

The implementation of Republic Act 10601 also known as the Agricultural and Fisheries Mechanization (AFMech) Law of 2013 mandated the Bureau of Agriculture and Fisheries Standards (BAFS) to develop standard specifications and test procedures for agricultural and fisheries machinery and equipment.

The Bureau, in collaboration with the Bureau of Agricultural and Fisheries Engineering (BAFE), concerned Department of Agriculture (DA) Bureaus, and attached agencies, Philippine Regulatory Board of Agricultural and Biosystems Engineering (PRB-ABE) and University of the Philippines Los Baños – Agricultural Machinery Testing and Evaluation Center (UPLB-AMTEC), embarked on a project entitled “Development of Philippine National Standard/ Philippine Agricultural Engineering Standard for Cacao Grinder”.

The production of Philippine Tablea starts by sorting the cacao beans to ensure uniformity in roasting. The selected beans undergo roasting to develop the color and flavor of the beans and to make the shells of the cacao brittle thus allowing the cacao bean to break into smaller pieces. Shelling and winnowing come next to remove the shells and other impurities to produce cacao nibs. Cacao nibs will then be subjected to grinding to produce cocoa liquor to be molded.

Grinding the cacao nibs to produce the cocoa liquor can result to minimum product recovery and affects the fineness of the grind. In view of this, the development of standard specifications and test procedures for this machine is essential for the advancement of the Philippine cacao industry.

This standard will serve as reference for Agricultural and Biosystems Engineers (ABEs) in the preparation and evaluation of specifications and test reports for cacao grinders pursuant to Republic Act No. 10915 otherwise known as the Philippine Agricultural and Biosystems Engineering Act of 2016.

This standard has been technically prepared in accordance with Bureau of Philippine Standards (BPS) Directives Part 3:2003 – Rules for the Structure and Drafting of International Standards.

The word “shall” is used to indicate mandatory requirements to conform to the standard.

The word “should” is used to indicate that among several possibilities one is recommended as particularly suitable without mentioning or excluding others.

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## **1 Scope**

This standard specifies the methods of test for cacao grinders. Specifically, it shall be used to:

- 1.1** verify the mechanisms, dimensions, materials and accessories of the cacao grinder and the list of specifications submitted by the manufacturer;
- 1.2** determine the performance of the machine;
- 1.3** evaluate the ease of handling and safety features; and
- 1.4** report the results of the tests.

## **2 References**

The following normative documents contain provisions, which, through reference in this text, constitute provisions of this National Standard

PAES 103:2000 Agricultural Machinery – Methods of Sampling

## **3 Definitions**

For the purpose of this standard, the following definitions apply.

### **3.1**

#### **fineness modulus**

reading obtained on a grindometer under specified conditions of test, indicating the depth of the groove(s) of the gauge at which discrete solid particles in the product are readily discernible

### **3.2**

#### **grindometer (Figure 1)**

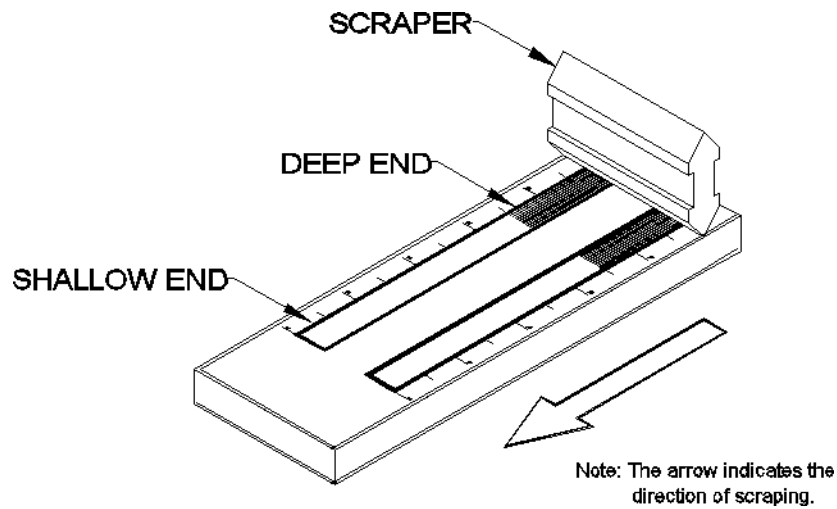
used to determine the fineness of grind and particle size of cacao liquor

### **3.3**

#### **overall height**

distance between the horizontal supporting plane surface and the horizontal plane touching the uppermost part of the cacao grinder

**NOTE** All parts of the cacao grinder projecting upwards are contained between these two planes.



**Figure 1 - Example of a Grindometer**

**3.4**

**overall length**

distance between the vertical planes at the right angles to the median plane of the grinder and touching its front and rear extremities

**3.5**

**overall width**

distance between the vertical planes parallel to the median plane of the machine, each plane touching the outermost point of the grinder on its respective side

**3.6**

**prime mover**

used to run the cacao grinder

**3.7**

**running-in period**

preliminary operation of the machine to make various adjustments prior to the conduct of the test until the operation is stable

**4 General Conditions for Test**

**4.1 Selection of cacao grinder to be tested**

Cacao grinder submitted for testing shall be sampled in accordance with PAES 103:2000 Agricultural Machinery – Methods of Sampling.

#### **4.2 Role of the test applicant**

The test applicant shall submit specifications and other relevant information about the cacao grinder. They shall abide with the terms and conditions set forth by the official testing agency, provide testing materials and shoulder other variable cost such as fuel, etc.

#### **4.3 Role of the representative of the test applicant**

An officially designated representative of the test applicant shall operate, demonstrate, adjust, repair as the case maybe and decide on matters related to the operation of the machine.

#### **4.4 Test site conditions**

The cacao grinder shall be tested as installed for normal operation. The site should have ample provisions for material handling, temporary storage, workspace and suitable for normal working condition. Adequate ventilation and lighting shall be provided in the area.

#### **4.5 Suspension/Termination of test**

If during the test run, the machine stops due to breakdown or malfunction so as to affect the machine's performance, the test may be suspended. If the machine will not be able to continue operation, the test shall be terminated.

### **5 Test Preparation**

#### **5.1 Preparation of the cacao grinder for testing**

A check shall be made by the manufacturer/distributor/dealer and testing authority that the cacao grinder has been assembled and installed in accordance with the instruction of the manufacturer.

In case of testing commercially manufactured cacao grinder, the machine sampled for acceptance, lot, routine, and type tests in accordance with PAES 103:2000 – Agricultural Machinery – Method of Sampling shall be submitted for test.

#### **5.2 Test instruments and other materials**

The suggested list of minimum field and laboratory test equipment and materials needed to carry out the cacao grinder test is shown in Annex A. These instruments should be calibrated regularly. It shall be physically checked and cleaned for operation before and after each test. A checklist of instruments and materials to be used shall be prepared before departure to and from the testing area.

### **5.3 Test materials**

Cacao nibs to be used shall be from commonly or locally grown cacao with 99% purity. The amount of test material to be supplied shall be sufficient for one hour of continuous operation. At least three (3) trials shall be conducted with minimum duration of fifteen minutes per trial. The excess amount shall be used for running-in prior to the actual conduct of test trials. However, if the test materials are beyond the recommended characteristics, the manufacturer has the option not to pursue the test.

### **5.4 Running-in and preliminary adjustments**

The cacao grinder shall have undergone a running-in period before starting the test. It shall be operated for sufficient duration with or without load at the test site by the official representative of the manufacturer. During the running-in period, the various adjustments of the machine shall be made according to the recommendation of the manufacturer.

**NOTE:** No other adjustments shall be permitted once the test commenced.

## **6 Pre-test Observation**

### **6.1 Verification of specifications**

The specifications claimed by the manufacturer and the physical details given in Annex B shall be verified by the testing agency. A stable and level surface shall be used as reference plane for verification of dimensional machine specifications.

The grinding mechanism, grinding chamber or any other parts that are in direct contact to the cocoa paste will also be used as reference for the verification of specification claimed by the manufacturer.

### **6.2 Test samples**

Random representative test samples shall be collected from the test material for determination of moisture content and particle size. Samples shall be prepared in such a way that test sample to be used for the running-in and in each test trial have identical characteristics in terms of moisture content and variety. Care should be taken so as to prevent alterations of the conditions of the test samples. Sampling procedure is shown in Annex C.

## **7 Performance Test**

### **7.1 Operation of the cacao grinder**

The cacao grinder shall be operated at the manufacturer's recommended setting of its components. The same speed and feeding rate recommended by the manufacturer shall be maintained during the test run. The testing authority shall

make all measurements, which form part of the test and take the prescribed samples. After the test run, the area shall be cleaned and then prepared for the next test trial. This procedure shall be repeated for the succeeding test trials.

## **7.2 Test trials**

A minimum of three (3) test trials, with duration of at least fifteen (15) minutes per trial, shall be adopted.

## **7.3 Sampling**

Samples shall be collected at different outlets using each test trial. Sampling procedure is shown in Annex C.

## **7.4 Data collection**

### **7.4.1 Duration of test**

The duration of each test trial shall start from the feeding of the test materials into the hopper (first drop) and ends at the last drop of the test materials into the hopper. However, all discharge from the different outlets shall be included after the cut-off time.

### **7.4.2 Noise level**

The noise emitted by the machine, with and without load, shall be measured using a noise level meter both at the location of the operators and baggers. The noise, expressed in decibel [dB (A)], shall be measured 50 mm away from the ear level of the operators and baggers.

### **7.4.3 Power requirement**

In each trial, a power meter/watt-hour meter shall be used to measure power requirement.

### **7.4.4 Speed of components**

The speed of the rotating shafts of the major components of the cacao grinder shall be taken using a tachometer.

**NOTE:** Measurements shall be taken with and without load.

## **7.5 Data recording and observations**

Record sheet for all data and information during the test is given in Annex D. Observations to be taken during the performance test shall be recorded in this sheet.

## **8 Laboratory Analysis**

Laboratory analysis shall be made to determine the moisture content and particle size of cacao nibs and cocoa liquor. The laboratory procedure to be followed in the analysis is given in Annex E while the data sheet is given in Annex F.

## **9 Presentation of results**

Machine specifications and the results of the test shall be presented in tabular form in which data shall be taken from Annexes B and D. A schematic diagram of the power transmission system and arrangement of the sieve shall also be included. Observations made on the machine while in operation shall be supported with photographs.

## **10 Formula**

The formulas to be used during calculations and testing are given in Annex G.

## **11 Test Report**

The test report shall include the following information in the order given:

- 11.1** Title
- 11.2** Summary of Results (including the performance compared with the criteria)
- 11.3** Purpose and Scope of Test
- 11.4** Methods of Test
- 11.5** Conditions of the Machine
- 11.6** Description of the Machine
- 11.7** Results and Discussions
- 11.8** Observations (include pictures)
- 11.9** Names and Signatures of Test Engineers



**Annex A**  
**(normative)**

**Minimum List of Field and Laboratory  
Test Equipment and Materials**

**A.1 Field Test Equipment and Materials**

<b>EQUIPMENT/MATERIAL</b>	<b>QUANTITY</b>
<b>A.1.1</b> Hand-held Tachometer	1
<b>A.1.2</b> Stop Watch Resolution: 0.1 second	2
<b>A.1.3</b> Measuring Tape	1
<b>A.1.4</b> Noise Level Meter Range: 30 – 130 dB (A)	1
<b>A.1.5</b> Weighing Scale Capacity: 100 kg Resolution: 0.1 kg	1
<b>A.1.6</b> Clamp-on AC/DC Power Meter 1000 V	1
<b>A.1.7</b> Camera	1

**A.2 Laboratory Test Equipment and Materials**

<b>EQUIPMENT/MATERIAL</b>	<b>QUANTITY</b>
<b>A.2.1</b> Digital Weighing Scale Resolution: 0.01 g Capacity: 2500 g	1
<b>A.2.2</b> Grindometer	1
<b>A.2.4</b> Air oven	1
<b>A.2.5</b> Desiccators	1
<b>A.2.6</b> Aluminum Moisture Cans	9
<b>A.2.7</b> Sample Bags	20
<b>A.2.8</b> Labeling Tags which include: Date of Test Cacao Grinder on Test Sample Source Variety Trial Number	20

**Annex B  
(informative)**

**Specifications of Cacao Grinder**

Name of Applicant (Distributor) :

Address :

Tel. No. :

Name of Manufacturer :

Address :

Tel. No. :

General Information:

Serial No.: \_\_\_\_\_ Brand/Model : \_\_\_\_\_

Classification: \_\_\_\_\_ Make : \_\_\_\_\_

Production date of the machine to be tested: \_\_\_\_\_

Item*	Manufacturer's Specification	Verification by the Testing Agency
<b>B.1 Main structure</b>		
<b>B.1.1 Overall dimensions (mm)</b>		
<b>B.1.1.1 Length</b>		
<b>B.1.1.2 Width</b>		
<b>B.1.1.3 Height</b>		
<b>B.1.2 Weight (kg), if applicable without the prime mover</b>		
<b>B.2 Rated output capacity (kg/h)</b>		
<b>B.3 Prime mover</b>		
<b>B.3.1 Electric motor</b>		
<b>B.3.1.1 Brand</b>		
<b>B.3.1.2 Model</b>		
<b>B.3.1.3 Serial Number</b>		
<b>B.3.1.4 Make</b>		
<b>B.3.1.5 Rated power (kW)</b>		
<b>B.3.1.6 Rated speed (rpm)</b>		
<b>B.3.1.7 Phase</b>		
<b>B.3.1.8 Voltage (V)</b>		
<b>B.3.1.9 Current (A)</b>		
<b>B.3.1.10 Frequency (Hz)</b>		
<b>B.4 Hopper</b>		
<b>B.4.1 Overall dimensions (mm)</b>		

<b>B.4.1.1</b> Length		
<b>B.4.1.2</b> Width		
<b>B.4.1.3</b> Height		
<b>B.4.2</b> Height from the ground (mm)		
<b>B.4.3</b> Material		
<b>B.4.4</b> Location		
<b>B.4.5</b> Means of attachment		
<b>B.5 Output Chute</b>		
<b>B.5.1</b> Overall dimensions (mm)		
<b>B.5.1.1</b> Length		
<b>B.5.1.2</b> Width		
<b>B.5.1.3</b> Height		
<b>B.5.2</b> Height from the ground (mm)		
<b>B.5.3</b> Material		
<b>B.5.4</b> Location		
<b>B.5.5</b> Means of attachment		
<b>B.6 Grinding Mechanism</b>		
<b>B.6.1</b> Type		
<b>B.6.2</b> Dimension, L x W x T (mm)		
<b>B.6.3</b> Means of attachment		
<b>B.6.4</b> Material		
<b>B.7 Safety devices</b>		
<b>B.8 Special features</b>		

\*The parameter will be checked upon availability.

**B.9** Illustration of transmission system

## **Annex C (normative)**

### **Sampling and Measurement for the Test Material**

#### **C.1 Sampling Procedures for RCB Input**

The conditions of the cacao nibs input such as moisture content and particle size to be used in each test shall be taken using three (3) “representative samples,” which represent the different conditions of cacao nibs input in the bulk. This is done by randomly taking samples at the top, middle and bottom portions of the bulk. Half of the sample shall be used for laboratory analysis and the other half shall be used for reference purposes or for an eventual second check in case of review. Samples representing the materials for each test trial shall be placed in appropriate containers for laboratory analysis.

#### **C.2 Sampling from Output Chute**

During each test trial, three (3) samples, each weighing 100 g shall be collected from the outlet of the cacao grinder to be analyzed in the laboratory for the determination of the particle size. The minimum amount of sample to be taken shall be twice as much as what is needed for a particular analysis.

#### **C.3 Handling of Samples**

All samples to be taken to the laboratory shall be placed in appropriate containers and properly labeled. If the samples are not to be immediately analyzed, it should be stored in proper condition and kept in dry and airtight containers.

#### **C.4 Other Measurements Required During the Test Run**

Data shall be taken on the speed of rotating components and noise level at operator’s or bagger’s location. For each data to be collected, there shall be a minimum of five (5) observations. These shall be taken with and without load. Before taking the data, it should be ensured that the feed rate, speed and other functional characteristics have stabilized.

#### **C.5 Measurement of Power Requirement**

Use a power meter to measure the voltage, current, and the total electric power consumption of the cacao grinder. There shall be three (3) sets of data with a minimum of five (5) observations per set taken with and without load.

Data shall be taken simultaneous with the collection of samples for laboratory analysis.

**Annex D  
(informative)**

**Performance Test Data Sheet**

Test Trial No.: \_\_\_\_\_ Date: \_\_\_\_\_  
 Test Engineers: \_\_\_\_\_ Location: \_\_\_\_\_  
 Assistants: \_\_\_\_\_ Machine: \_\_\_\_\_  
 Test Requested By: \_\_\_\_\_ Manufacturer: \_\_\_\_\_

Items	Trial 1	Trial 2	Trial 3	Average
<b>D.1 Conditions of cacao nibs</b>				
D.1.1 Source				
D.1.2 Variety				
D.1.3 Moisture content (%)				
D.1.4 Average Particle Size				
<b>D.2 Weight of input (kg)</b>				
<b>D.3 Input capacity (kg/h)</b>				
<b>D.4 Operating time (h)</b>				
<b>D.5 Grinding capacity (kg/h)</b>				
<b>D.6 Cocoa Liquor (kg)</b>				
<b>D.7 Speed of components (rpm)</b>				
D.7.1 Prime mover				
D.7.1.1 Without load				
D.7.1.2 With load				
D.7.2 Grinder shaft				
D.7.2.1 Without load				
D.7.2.2 With load				
<b>D.8 Noise level [dB (A)]</b>				
D.8.1 Feeder				
D.8.1.1 Without load				
D.8.1.2 With load				
D.9.2 Bagger				
D.9.2.1 Without load				
D.9.2.2 With load				
<b>D.9 Power requirement</b>				
D.9.1 Power (kW)				
D.9.1.1 Without load				
D.9.1.2 With load				
D.9.2 Current (A)				
D.9.2.1 Without load				
D.9.2.2 With load				
D.9.3 Voltage (V)				
D.9.3.1 Without load				
D.9.3.2 With load				

**D.10 Other Observations**

**D.10.1** Ease of transporting the machine

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**D.10.2** Ease of cleaning the machine

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**D.10.3** Ease of adjusting and repairing of parts

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**D.10.4** Ease of loading input and collecting output

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**D.10.5** Safety

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**D.10.6** Labor Requirements

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**D.10.7** Failure or abnormalities that may be observed on the machine or its component parts during and after the cleaning operation.

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**D.10.8** Others

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## **Annex E (normative)**

### **Laboratory Analysis**

#### **E.1 Moisture Content Determination of Cacao Nibs**

At least five (5) representative samples taken randomly at 25 g each shall be taken for moisture content determination preferably using the Air-Oven Drying Method or any calibrated moisture meter. It should be determined before the grinding of the cacao nib samples.

#### **E.2 Determination of the Uniformity of Cacao Nib Samples**

Three-100 g sample shall be taken from the test sample. A 2 ½ mesh (8 mm), 3 mesh (6.73 mm), 3 ½ mesh (5.66 mm), 4 mesh (4.76 mm), 5 mesh (4 mm), 6 mesh (3.36 mm), 7 mesh (2.83 mm), and a shaker shall be used. Place the sieve in sieve shaker in descending order with 2 ½ mesh sieve at the top. The sieve shaker shall be operated for five (5) minutes. The samples from each sieve shall be taken and weighed. The weight of nibs from each sieve shall be taken as percentage size of the sample size.

#### **E.3 Determination of Fineness of Grind of Cocoa Liquor**

The fineness of the grind of cocoa liquor can be determined with the use of a grindometer.

#### **E.4 Determination of Total Grinding Loss**

Compute for total grinding loss as the amount of uncollected material or the difference on the amount of cacao nibs input and the cocoa liquor output, expressed in percent.



**Annex F  
(informative)**

**Laboratory Analysis Data Sheet**

Machine Tested: \_\_\_\_\_ Analyzed By: \_\_\_\_\_  
 Date of Test: \_\_\_\_\_ Date Analyzed: \_\_\_\_\_

**F.1 Moisture Content (% wet basis) of Cacao Nibs Conditions**

<b>Average</b>					

**F.2 Particle Size (Cacao Nibs and Cocoa Liquor)**

<b>Average</b>		

**F.3 Total Grinding Loss Determination**

Trial No.		Total Grinding Loss	
		Duration	
		Sample Weight (g)	Total (kg)
<b>1</b>	<b>A</b>		
	<b>B</b>		
	<b>C</b>		
<b>Average</b>			
<b>2</b>	<b>A</b>		
	<b>B</b>		
	<b>C</b>		
<b>Average</b>			
<b>3</b>	<b>A</b>		
	<b>B</b>		
	<b>C</b>		
<b>Average</b>			
<b>General Average</b>			

## Annex G (normative)

### Formula Used During Calculations and Testing

#### G.1 Moisture Content

$$MC_{\text{wet basis}} = \frac{W_i - W_f}{W_i} \times 100$$

where:

$MC_{\text{wb}}$	=	Moisture content (%)
$W_i$	=	Initial mass of the sample (g)
$W_f$	=	Final mass of the sample (g)

#### G.2 Capacity

##### G.2.1 Grinding

$$G_m = \frac{W_{ic}}{T}$$

where:

$G_m$	=	Grinding capacity (kg/h)
$W_{ic}$	=	Weight of input cacao nibs (kg)
$T$	=	Total operating time (h)

##### G.2.2 Input

$$C_i = \frac{W_{ic}}{T_i}$$

where:

$C_i$	=	Input capacity (kg/h)
$W_{ic}$	=	Total weight of cacao nibs input (kg)
$T_i$	=	Input time (h)

##### G.2.3 Output

$$C_o = \frac{W_{cl}}{T_o}$$

where:

$C_o$	=	Output capacity (kg/h)
$W_{cl}$	=	Total weight of cocoa liquor (kg)
$T_o$	=	Output time (h)

**G.3 Grinding Recovery**

$$G_r = \frac{W_c}{W_{ic}} \times 100$$

where:

$G_r$	=	Grinding recovery (%)
$W_{cl}$	=	Weight of cocoa liquor (kg)
$W_{ic}$	=	Weight of cacao nibs input (kg)

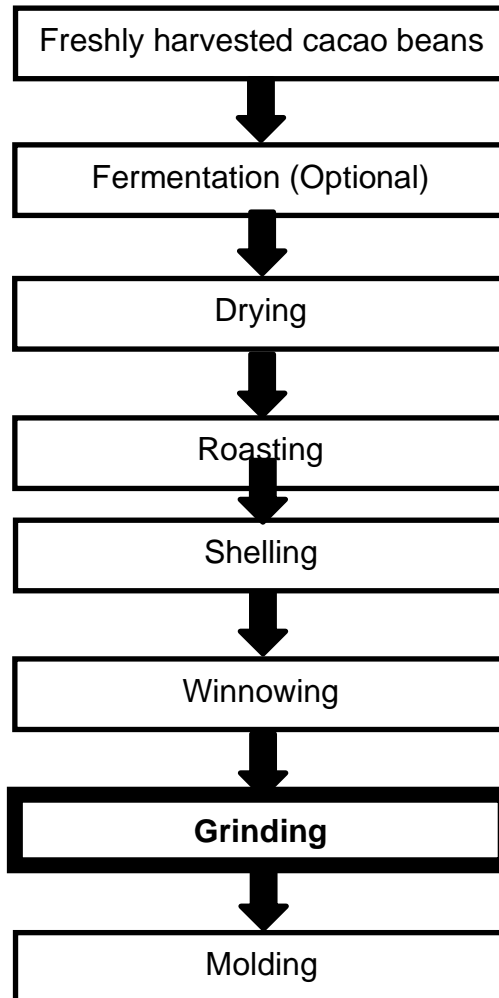
**G.4 Total Grinding Loss**

$$L_t = 100 - G_r$$

where:

$L_t$	=	Total grinding loss (%)
$G_r$	=	Grinding Recovery (%)

**Annex H  
(informative)  
The Process Flow Chart in Making Philippine Tablea**



- (1) ISO 1524 – Paints, Varnishes and Printing Inks – Determination of Fineness of Grind
- (2) ASTM D1316 – Test Method for Fineness of Grind of Printing Inks by NPIRI Grindometer



*Your partner in product safety*

**BUREAU OF PHILIPPINE STANDARDS (BPS)**

**Department of Agriculture  
Bureau of Agriculture Fisheries and Standards**

**Technical Working Group on the Development of the  
Philippine National Standard for Cacao Grinder**

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