

A close-up photograph of a stack of broken chocolate bars. The bars are dark brown and have a slightly textured surface. They are stacked in a way that shows their edges and some of their broken pieces. Drizzles of white cream or frosting are visible on the top and sides of the chocolate pieces. The background is a soft, out-of-focus brown color.

UCSD ENERGY CLUB PRESENTS:

THE PHASES OF CHOCOLATE

Chocolate's journey



600AD

- Mayans, Aztec, Incas
- Xocolatl
- Cocoa drink made of crushed beans, spices and water

Chocolate's journey



1520 - 1660

- Brought to Spain, Italy, France
- Added sugar, but still bitter
- Drink for the wealthy

Chocolate's journey



Early 1700's

- Brought to England
- Milk added to the drink
- Chocolate houses

Chocolate's journey



1828

→ Van Houtens developed Dutching process to better disperse cocoa in hot water and reduce bitter flavor

Chocolate's journey



1847

- First chocolate bar produced in England
- Joseph Fry

Components of chocolate



Cocoa pod

Cocoa bean

Cocoa



Sugar



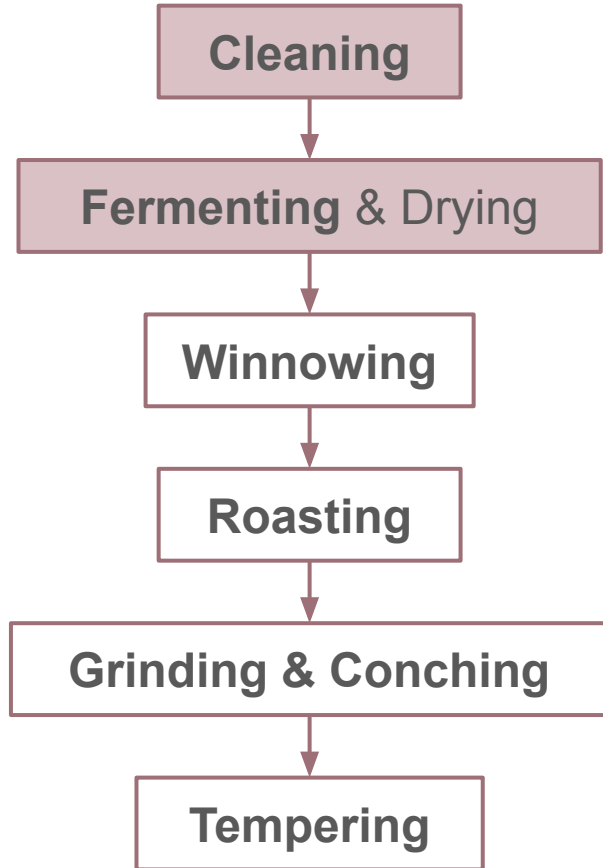
Cocoa nibs



Milk

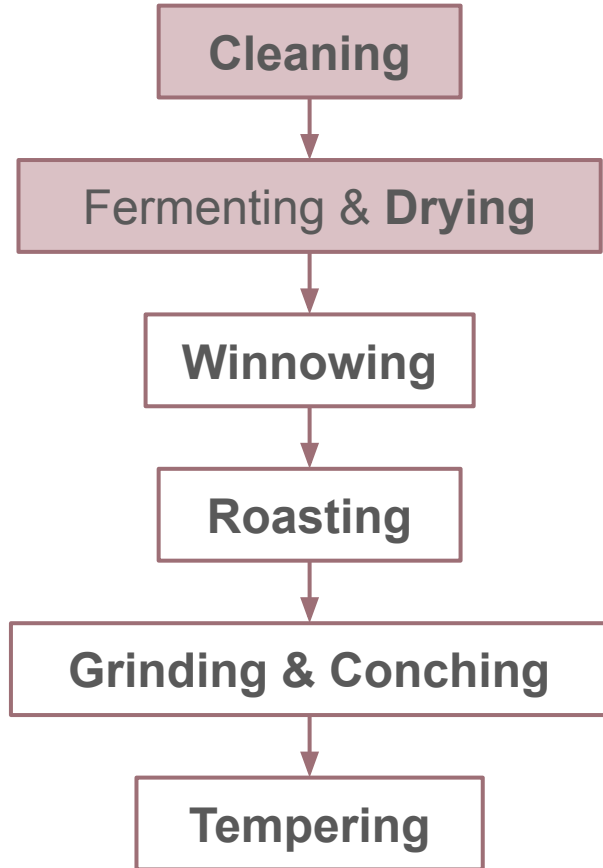
Genetic varieties: Criollo, Forastero, Trinitario, Nacional

From bean to bar process



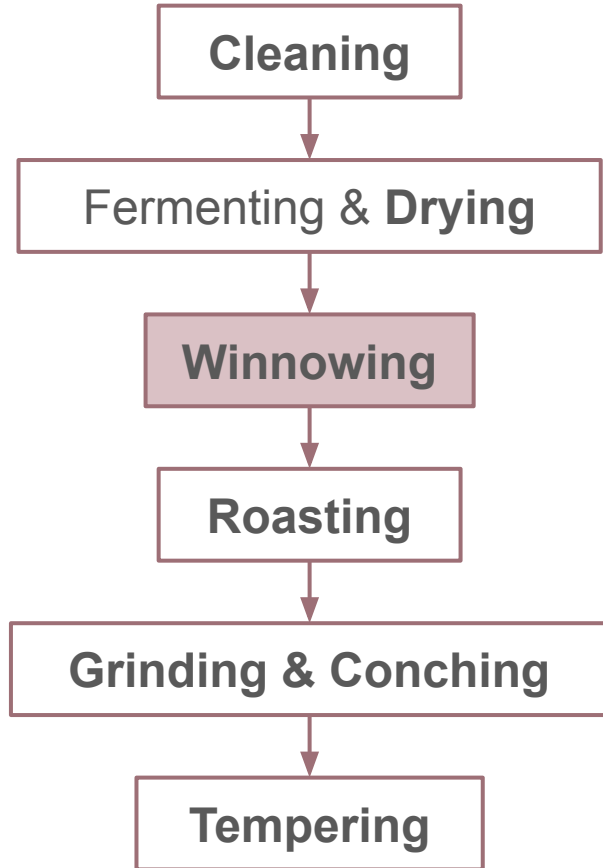
→ Beans separated from pods and left to ferment at 120C for ~5 days

From bean to bar process



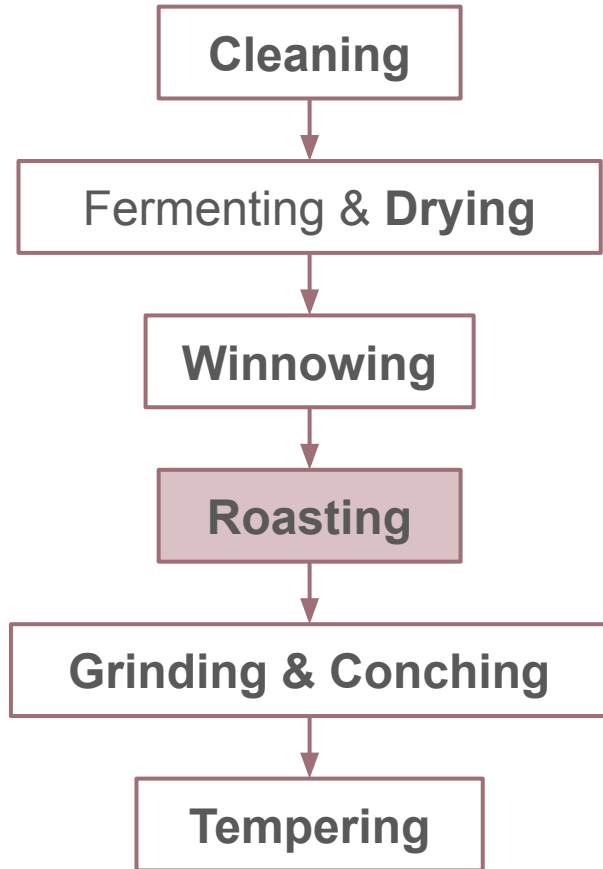
→ Beans are dried to bring down moisture content

From bean to bar process



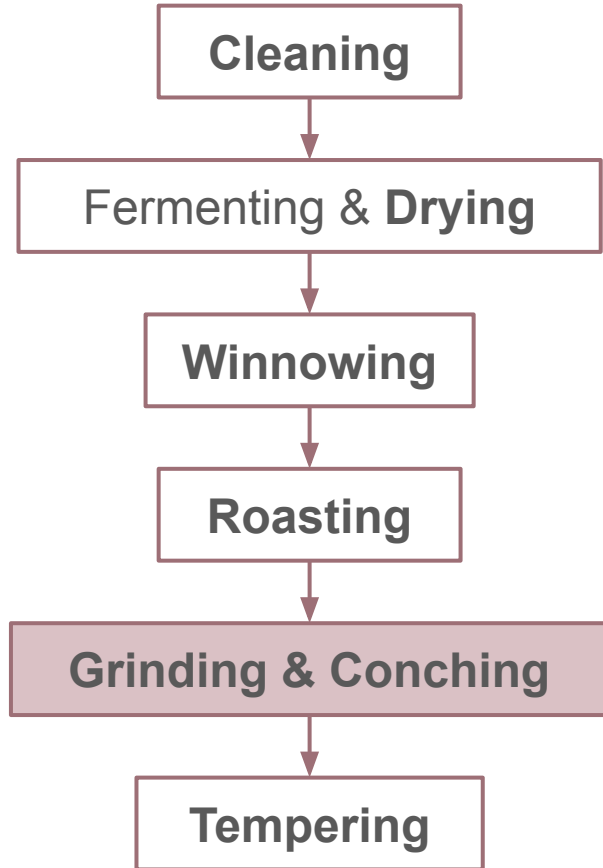
→ Beans are ground to remove shell, leaving just the nibs

From bean to bar process



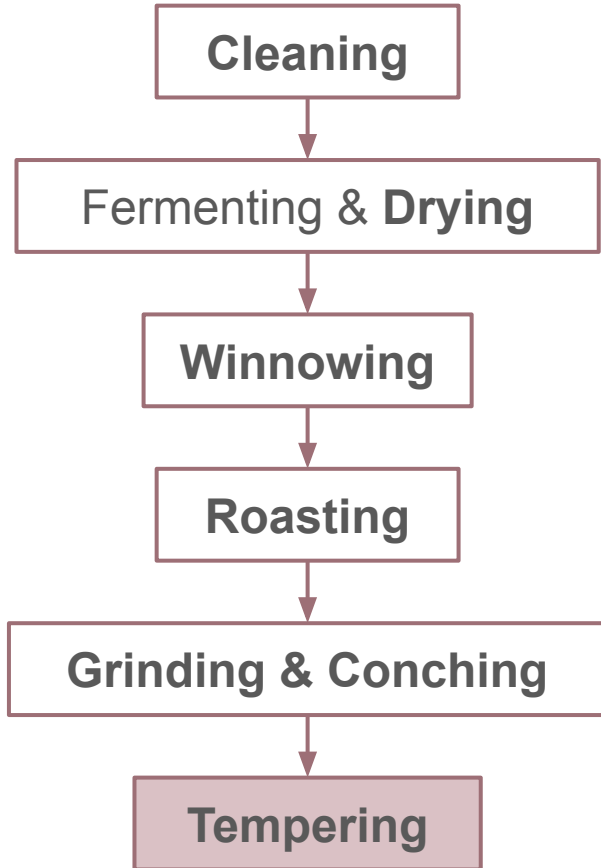
→ Nibs are roasted to kill micro-bacteria and remove acidic and bitter flavors

From bean to bar process



- Chocolate liquor is ground to reduce particle size to $\sim 30\mu\text{m}$.
- Cocoa butter and sugar are added

From bean to bar process



Tempering

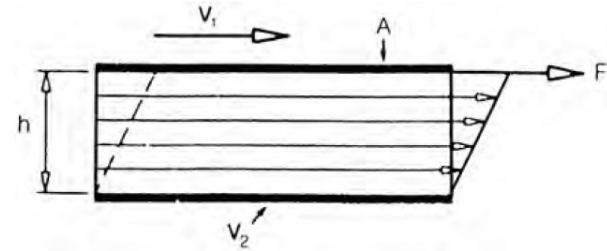
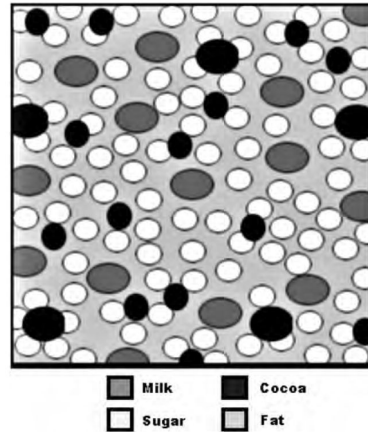
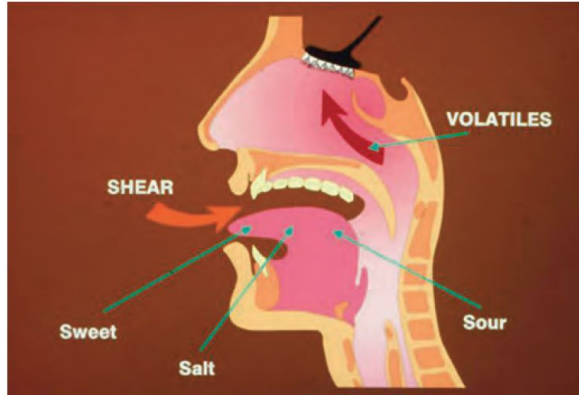
Fat blooms



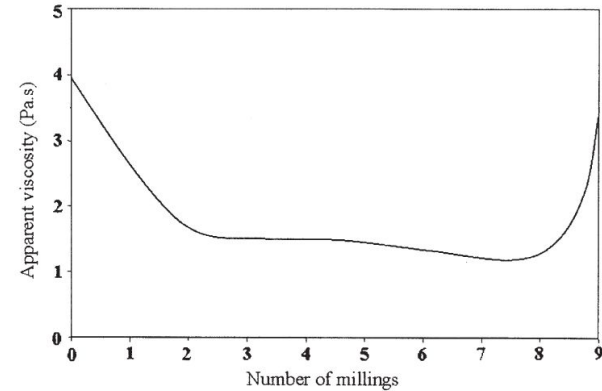
→ Process of heating and cooling chocolate to achieve the right crystal structure for glossy, snappy chocolate

Cocoa motion - The role of viscosity

Viscosity: Internal friction to motion



Applying shear force to a liquid

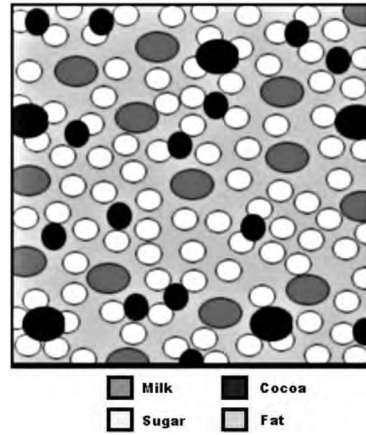
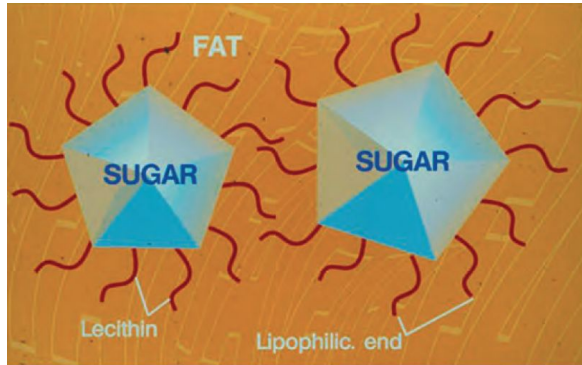


Viscosity of cocoa liquor ground to different finenesses showing non-newtonian behavior

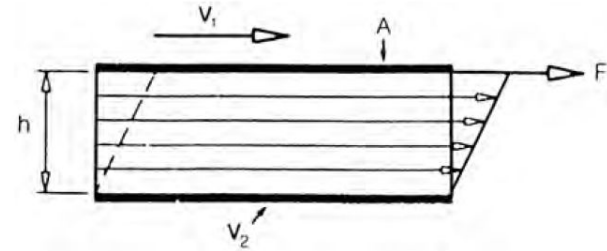
- Ideal cocoa particle size is 30 μm
- Fat aids in chocolate flow
- Emulsifiers help smoothen interface between fat and solids

Cocoa motion - The role of viscosity

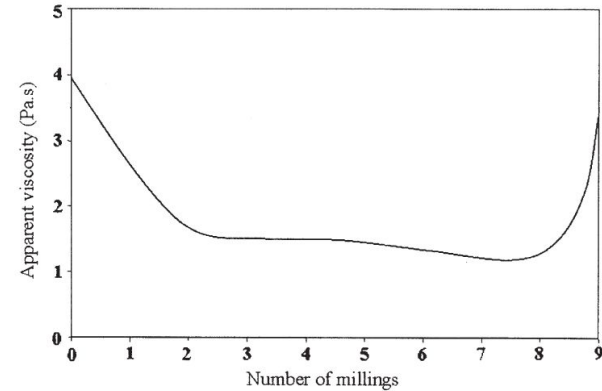
Viscosity: Internal friction to motion



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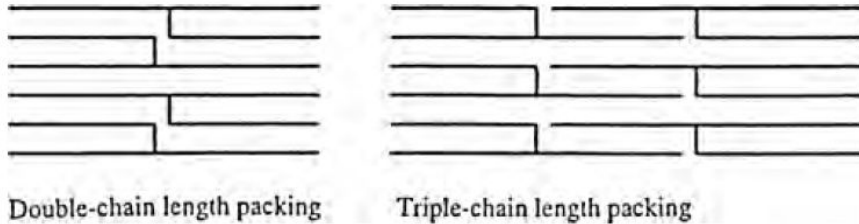
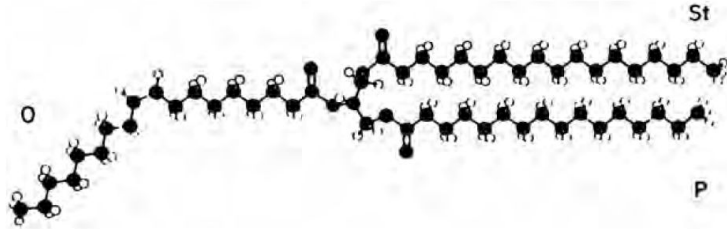


Applying shear force to a liquid

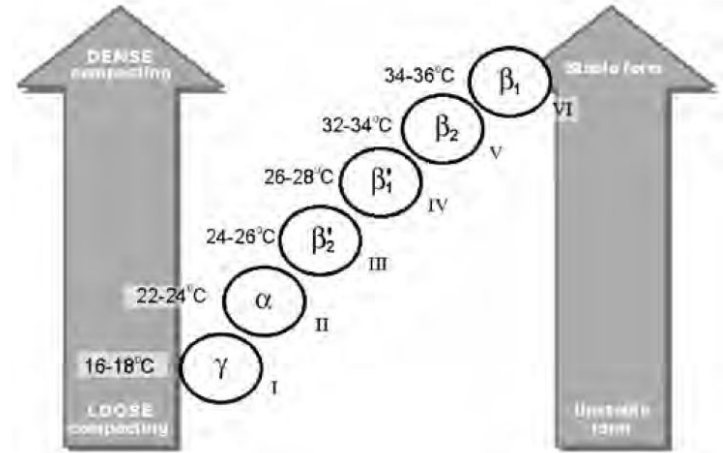


Viscosity of cocoa liquor ground to different finenesses showing non-newtonian behavior

Fat crystallization



Different crystal structure packing arrangements



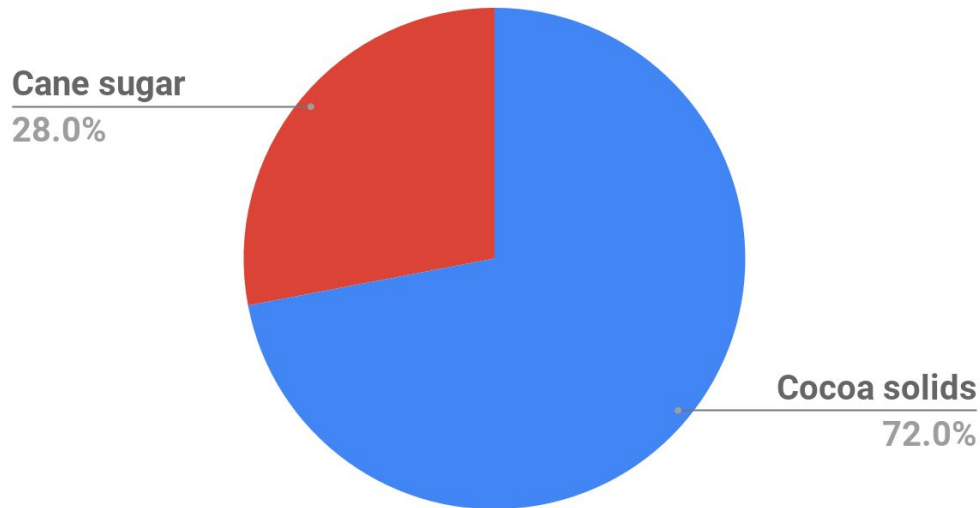
- Cocoa butter has six different phases
- Type V is ideal for its glossy appearance, snap and resistance to fat blooms
- Higher fat content leads to lower melting temperature

Chocolate Tasting Competition

1. There will be 7 different chocolates on the table
2. Try to match each chocolate with the correct origin/composition
3. Write down your answers on the sheet
4. The person with the highest number of correct answers wins a prize!

Nibble: Dominican Republic

Ingredients:



Grown in Finca Elvesia,
Dominican Republic

- Tropical
- Regular rains
- Cold nights

Genetic variety:
Trinitario

Manufacturing:
Nibs are stone-ground
and mixed with sugar

Nibble
CHOCOLATE

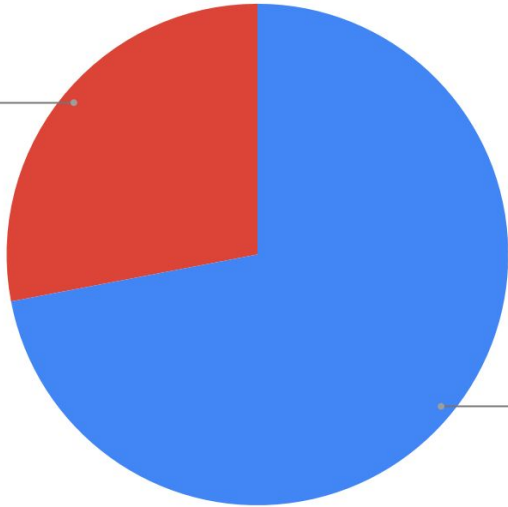
Flavor profile:

- ★ A rich and bold chocolate with balanced earthy flavors and coffee notes.
- ★ Cherry, ripe mango and banana with bright acidity

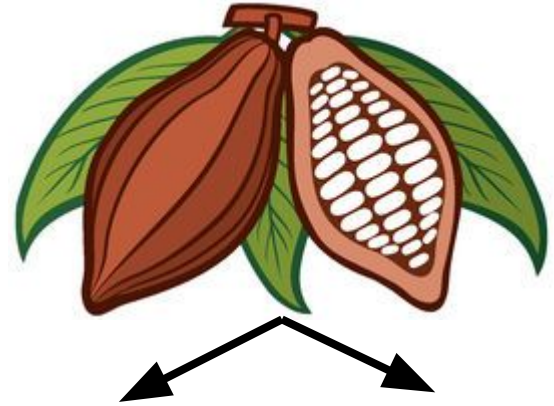
Nibble: Madagascar

Ingredients:

Cane sugar
28.0%



Cocoa solids
72.0%



Grown in Sambirano Valley, Madagascar

→ Mountain ranges and trade winds assist rain in flooding the nearby rivers, depositing extremely fertile alluvia

→ Leads to the growth of sweeter and less bitter cocoa

Genetic variety:
Trinitario

Nibble
CHOCOLATE

Flavor profile:

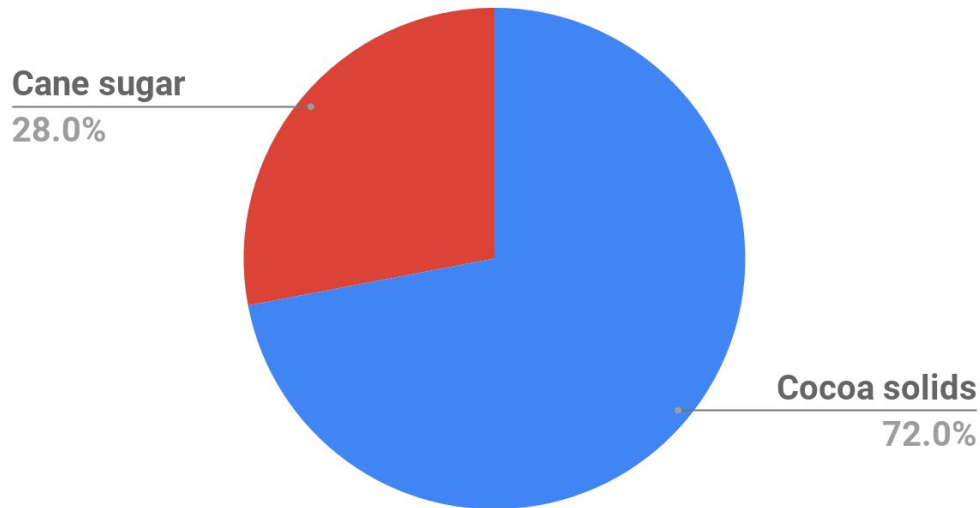
- ★ A bright and exciting chocolate with citrus, raspberry and plum notes, underlying earthiness and a zesty finish

Manufacturing:

Nibs are stone-ground and mixed with sugar

Nibble: Peru

Ingredients:



Grown in Tumbes, Peru
→ Coastal climate

Genetic variety:
Criollo

Manufacturing:
Nibs are stone-ground
and mixed with sugar

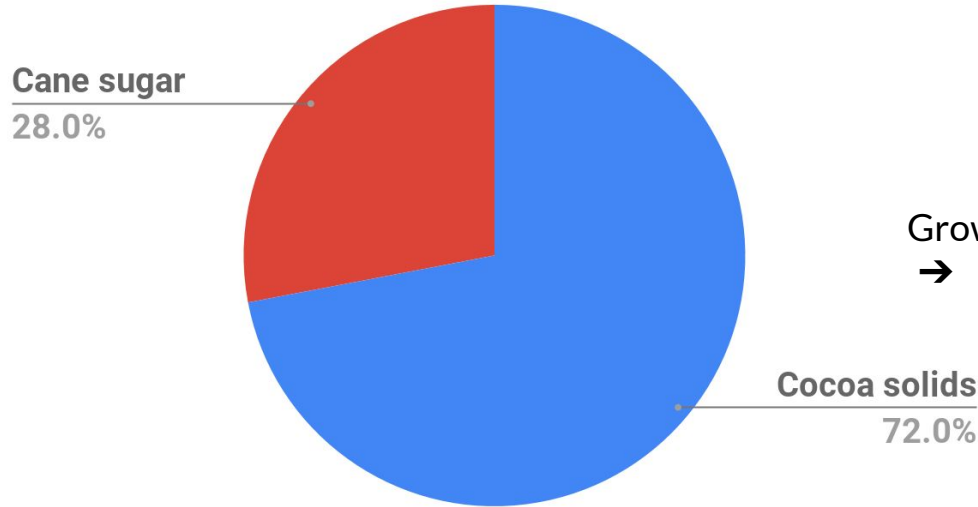
Nibble
CHOCOLATE

Flavor profile:

- ★ A delightful complex chocolate with caramel and dry fruit raisin notes, underlying maltiness and a long lasting finish.

Nibble: Brazil

Ingredients:



Grown in Bahia, Brazil

→ Cultivation is integrated into the native forests (as opposed to crops) which generates a unique texture, and flavor

Genetic variety:
Trinitario

Manufacturing:
Nibs are stone-ground and mixed with sugar

Flavor profile:

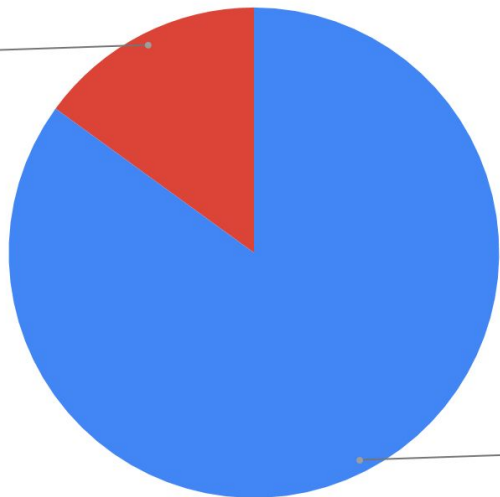
- ★ A stimulating and balanced chocolate with floral and tropical fruit notes, hints of lemongrass and pineapple, great acidity and a long lasting finish with macadamia undertones.

Nibble
CHOCOLATE

Nibble: Brazil, extra dark

Ingredients:

Cane sugar
15.0%



Cocoa solids
85.0%



Grown in Bahia, Brazil

→ Cultivation is integrated into the native forests (as opposed to crops) which generates a unique texture, and flavor

Genetic variety:
Trinitario

Manufacturing:
Nibs are stone-ground and mixed with sugar

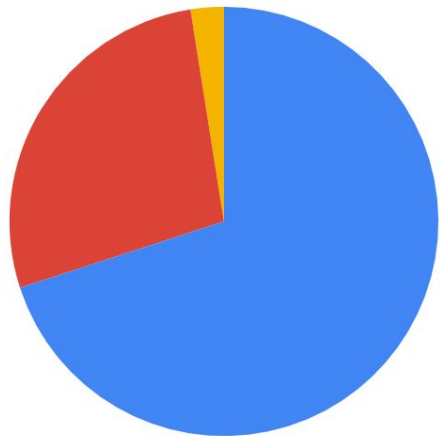
Flavor profile:

- ★ A stimulating and balanced chocolate with floral and tropical fruit notes, hints of lemongrass and pineapple, great acidity and a long lasting finish with macadamia undertones.



Green & Black's: Dark 70%, Organic

Ingredients:



- Cocoa solids
- Cane sugar
- Cocoa butter, Soy lecithin, Vanilla



Blend of beans from
different regions

Genetic variety:
Trinitario

Manufacturing:
Conventional method
(as shown before)

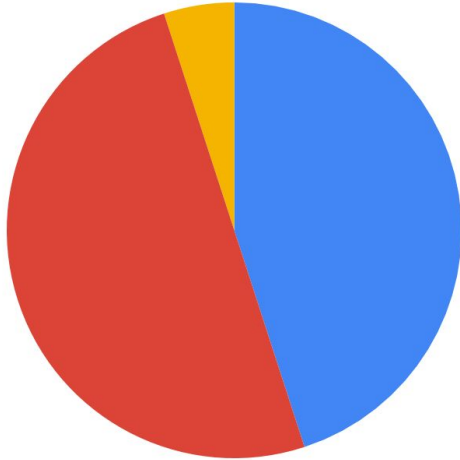
Flavor profile:

- ★ Complex fruit notes and intense bittersweet chocolate aromas
- ★ Blend leads to more balanced flavors
- ★ Vanilla added to enhance chocolate aromas

**GREEN
& BLACK'S**

Hershey's: Special Dark

Ingredients:



- Cocoa solids
- Sugar
- Cocoa butter
- Cocoa powder
- Milk fat
- Lactose
- Soy lecithin
- Emulsifier: Polyglycerol polyricinoleate



Blend of beans from
different regions

Genetic variety:
Forastero

Manufacturing:
Conventional method
(as shown before)

Flavor profile:

- ★ Made from Forastero beans, which are often considered to be of lower quality than Trinitario and Criollo

HERSHEY'S

Chocolate Tasting Competition

1. There will be 7 different chocolates on the table
2. Try to match each chocolate with the correct origin/composition
3. Write down your answers on the sheet
4. The person with the highest number of correct answers wins a prize!

References

1. The Science of Chocolate, Stephen Beckett, 2008
2. Bean to Bar Chocolate, Megan Giller, 2017
3. Jennifer and Sandra at Nibble Chocolate - 2754 Calhoun St, San Diego

Correct Matching Sequence

A → Peru

B → Hershey's

C → Brazil, extra dark

D → Dominican Republic

E → Madagascar

F → Green & Black's

G → Brazil

Bonus Question → White 1 Milk 2 Dark 3