I Eat Math for Breakfast

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Introduction:

So, you're craving a bag of M&M's, and you sloth your way into the kitchen cabinet and see your little sister's mini-M&M's. As you avoid your chemistry project, you turn on a math video to still feel productive whilst munching away on mini-M&M's. They taste better than usual and you wonder if it's the joy of getting to them before your sister but the video mentions how many report mini-M&M's tasting better than the normal-sized ones. It mentions how when you shrink their size, the volume of chocolate decreases by a greater factor than the surface area of the sugar shell-coating. This creates a greater ratio of sweet shell to chocolate, which makes it seem sweeter and taste better (Hudson-Smith, 2019).

	Standard M&Ms	Mini M&Ms
% Chocolate (Volume)	73.9 +/ 2	78.9 +/- 4.4
% Shell (Volume)	26.1 +/- 2	21.1 +/- 4.4
% Sugars (Mass)	62.6	63.7
Calories/Gram	5.01	5.00
Surface Area-to-Volume (cm^{-1})	7.8	11.1

Figure 1: Table comparing standard M&M's to mini-M&M's (Hudson-Smith, 2019)

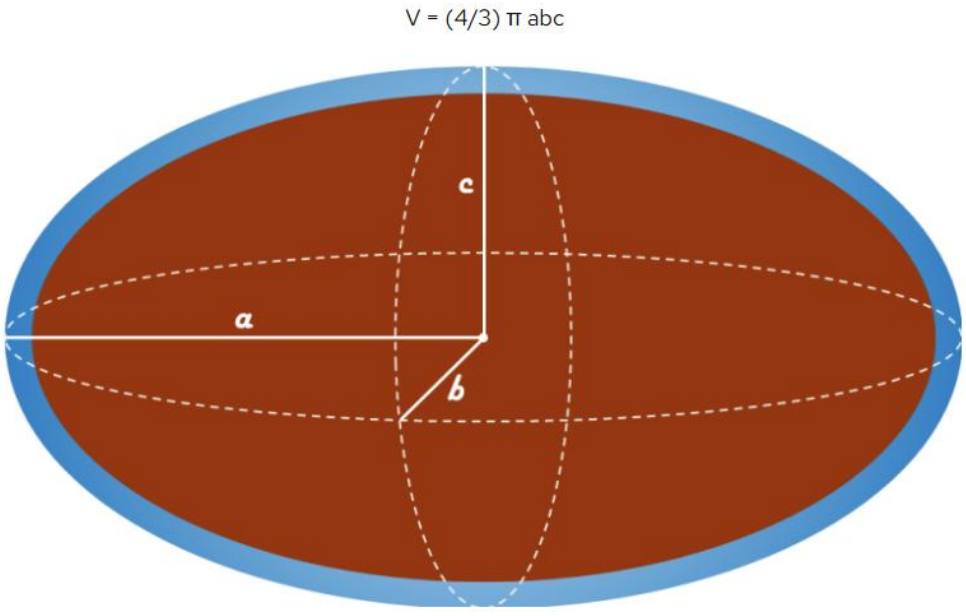

Figure 2: Drawing of an ellipsoidal M&M with brown representing the chocolate core and blue representing the candy shell (Hudson-Smith, 2019)

Now, this isn't how I figured it out. I don't even have a younger sibling. I don't remember how I found this out, but it's always led me to wonder. What are the mathematically

best-tasting food sizes? Should vegetables be sliced or diced? Is ice cream better than a milkshake? I'm here to satiate your hunger (pun intended) for food knowledge.

However, first, allow me to explain the basics. When something changes in size, k is the factor by which the lengths (1D) are changed. Area changes by k^2. Volume changes by k^3. For example, if square A has sides of 3m, and square B has sides of 9m. B's sides are 3 times bigger so k=3. The area of B (81) is k^2 (9) times bigger than the area of A (9). If square A and B were faces on cubes A and B. The volume of cube B (729) would be k^3 (27) times bigger than that of A (27).

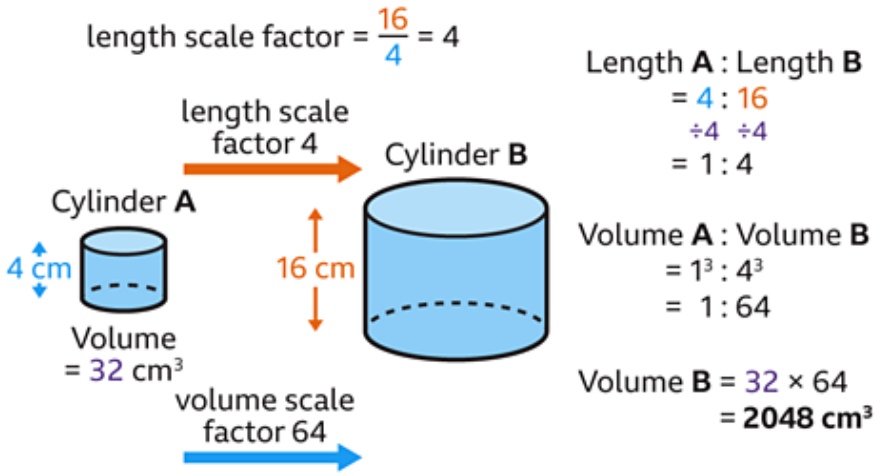

Figure 3: Image showing scale factor affecting volume ratio (BBC Bitesize, n.d.)

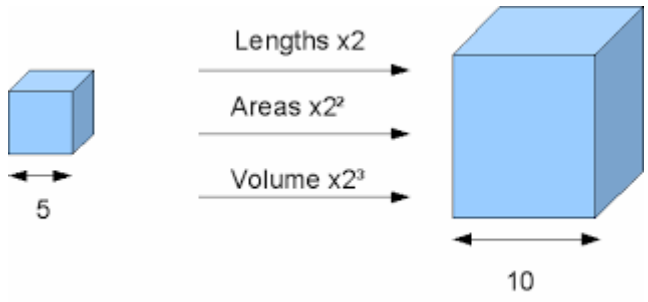

Figure 4: Additional Scale factor example (Cassiopeia, n.d.)

Now that we're all caught up. I'm going to pick the generally accepted best tasting food from each food group (fruits, vegetables, carbohydrates, protein, fats and oils and dairy), then analyse at what size they taste best.

Fruits:

In the blue corner, is the prince of pulp, the tart titan, the passion fruit. In the red corner, is the tropical treasure, the ripe royal, the mango. The winner is… mango. Mango won by a landslide compared to other fruits, as it is commonly referred to as “the king of fruits” online (Aber, 2024).

The taste of a mango is mainly concentrated within its juices (Blackwood, 2021). Therefore, for the best taste, volume must be favoured over surface area. If there are two mangoes of the same weight. The smaller mango will taste better as there is a higher density of juice per bite of mango. The carbohydrate content of mango is 14 g/100 g. Major sugars found in mango fruit are sucrose (50%) (Hussain et al., 2021). On average, Kent mangoes weigh between 400 to 800 grams (Cobos, 2026) and are 3–30 cm long.

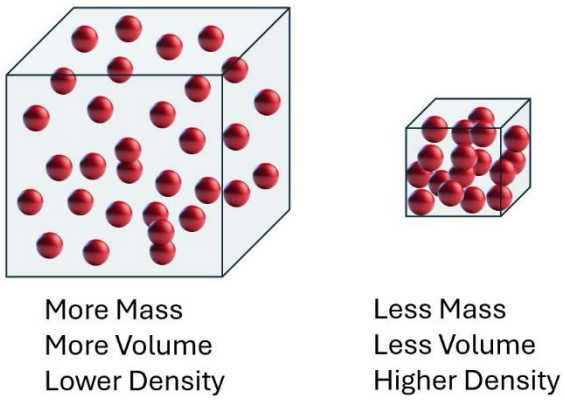

Figure 5: Density diagram (StickMan Physics, n.d.)

For efficiency, the mango will be assumed to be an ellipsoid, with a=1,5 cm (as the diameter would be the smallest length for a mango, 3cm); b=1 cm; c=1 cm, based on general estimations of a mango’s shape.

$$V = \frac{4}{3}\pi \mathrm{abc}$$

$$V = \frac{4}{3}\pi(1{,}5)(1)(1)$$

$$V = 2\pi\ cm^3$$

$$\rho = \frac{m}{v}$$

$$\rho = \frac{800}{2\pi}$$

$$\rho \approx 127{,}32395\ g/cm^3$$

$$sucrose\ density = 0.5\left(\frac{14}{100}\right)(127{,}32395)$$

$$sucrose\ density = 8{,}91\ g/cm^3$$

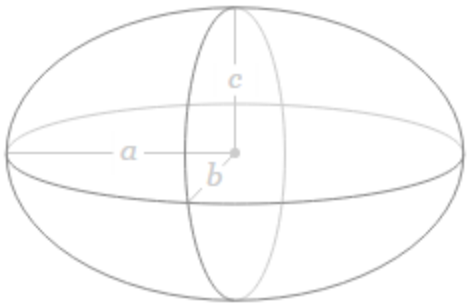

Figure 6: dimensions of an ellipsoid (BYJUS, n.d.)

For comparison, table sugar has a sucrose density of Solid sucrose (sugar) has a density of approximately 1.587 g/cm3. Thus, this optimal mango would be as sweet as a mango mathematically can be.

Vegetables:

We can skip this one because nothing will make vegetables taste good. However, on a more serious note, this one is more difficult to find as there seemed to be less of a consensus on the best vegetable. However, one of the most popular is carrots.

Baby carrots taste worse than normal carrots. Baby carrots are shaved of their protective skin layer, which exposes unprotected surface to the air where they lose moisture and their sweet flavour.

Dicing generally creates smaller cubic pieces compared to larger circular slices. The increase in surface area releases more juices when cooked or eaten. Assume the diameter of the carrot = 2cm; the thickness of the cut = 1cm into the length of the carrot. The diced carrot will be in 4 pieces.

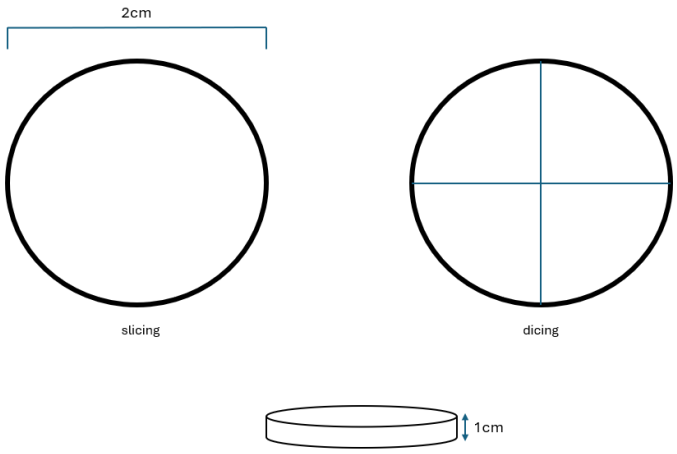

Figure 7: Diagram visualising the scenario of dicing versus slicing a carrot

Slicing

$$Surface\ area\ of\ cylinder = 2\pi rh + 2\pi r^2$$
$$Surface\ area\ of\ cylinder = 2\pi(1)(1) + 2\pi(1^2)$$
$$Surface\ area\ of\ cylinder = 4\pi$$
$$Surface\ area\ of\ cylinder \approx 12{,}57cm^2$$

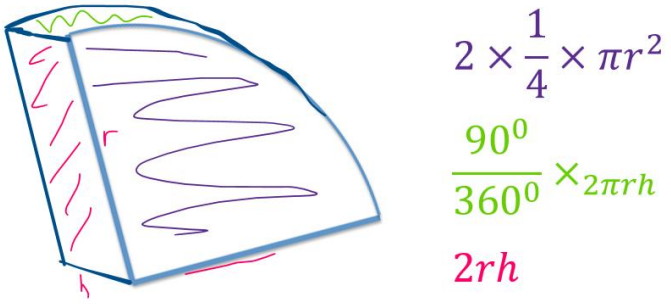

Figure 8: Diagram visualising a diced piece of carrot

Dicing

$$Surface\ area = 4\left[\left(2 \times \frac{1}{4} \times \pi r^2\right) + \left(\frac{90°}{360°} \times 2\pi rh\right) + (2rh)\right]$$
$$Surface\ area = 4\left[\left(2 \times \frac{1}{4} \times \pi \times 1^2\right) + \left(\frac{90°}{360°} \times 2\pi \times 1 \times 1\right) + (2 \times 1 \times 1)\right]$$
$$Surface\ area \approx 20{,}57cm^2$$

Thus, dicing > slicing. For carrots and many other vegetables, dicing is better than slicing, whether cooked or eaten raw.

Carbohydrate:

Similarly, to the example of cutting versus dicing of carrots, thinner cut chips (or fries for the United States of America) from the same size potato create more total surface area. This means more crispy outside of the potato per cm^3 of potato flesh, as more surface area is in contact with the oil. This creates crispier and generally better liked chips. This is why wedges are generally considered less crispy.

Protein:

When something is cooked, heat first cooks the outside. Heat conducts from the surface inward.

Bigger cuts have a larger distance from the centre to the surface. Thus, heat takes a long time to travel to the core. Smaller cuts have a shorter distance, and, thus, a shorter cook time.

If at a certain temperature, it takes 10 minutes for heat to penetrate 1,27 cm (1/2 inch) towards the centre of a piece of meat. Meat for hotpot, where food needs to be cooked quickly, is estimated to be cut to 2 mm (0,2 cm) thick. A roast is at least 2 inches (5,08 cm) thick (Alderspring, n.d.).

Thin cut

$$minimum\ cook\ time = 10\ \left(\frac{0{,}2}{1{,}27}\right)$$

$$minimum\ cook\ time \approx 1{,}57\ minutes$$

Thick cut

$$minimum\ cook\ time = 10\ \left(\frac{5{,}08}{1{,}27}\right)$$

$$minimum\ cook\ time = 40\ minutes$$

Therefore, smaller cuts (Strips, cubes, steaks) cook faster and are ideal for high-heat methods (Searing, stir-frying, pan-frying, grilling). As their size decreases, the surface

area decreases by a lower factor than the volume, providing a higher crust-to-meat ratio (more Maillard reaction per bite).

Larger cuts (Roasts, whole tenderloin, ribs) cook lower and are ideal for lower heat methods (Roasting, braising, baking, slow-cooking), providing less crust-to-meat ratio. However, the long cooking time gives time for the collagen to be broken down, resulting in a more tender texture.

Dairy:

Grated cheese tastes better than sliced because the increased surface area allows more oxygen exposure, releasing more aromatic compounds. As smell is linked to taste, this intensifies the flavour (National Center for Biotechnology Information, 2023). More surface area is in contact with the taste buds, which intensifies flavours. intensifying flavour and enabling faster, more even melting.

The increase in surface area affects how it reacts with heat. The shreds melt faster than the slices as more surface area is absorbing heat and there is a short distance to the middle of each shred of cheese. They melt quickly and evenly (as shredders are usually uniform), providing a creamier texture for dishes.

Smaller shreds warm up faster in the mouth. Taste buds react differently to higher temperatures of sugar, which increases the volatility of flavour compounds, making the flavour seem more intense, richer, and sweeter (Green, n.d.). This is usually preferred to the relatively cold slices.

The differences in taste for milkshake vs ice cream are mostly due to the fact that milkshakes have added milk and often add syrups and flavourings. There are also temperature differences as milkshakes are often warmer than ice cream. This leads many to prefer milkshakes. A lesser factor is the differences in states of matter, which will be explained in the Fats and Oils.

Fats and oils:

Melted butter is often seen as more prestigious than solid butter. You’re likely expecting this to compare the surface area and volume of the two. However, the comparison is how much surface area of the tongue they cover. Liquids flow, covering more surface area of the tongue swiftly. Liquids interact with taste receptors more

quickly than solids. This (as well as the heat of melted butter making the flavour more vivid for taste buds) gives melted butter a “stronger” flavour.

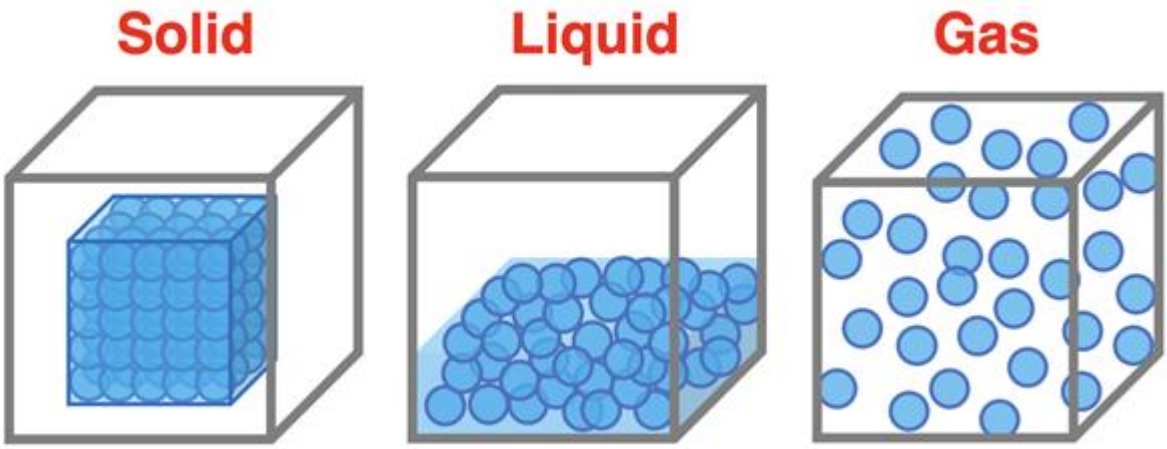

Figure 9: Diagram of states of matter (ThePhysicsClassroom, n.d.)

Conclusion:

Ultimately, math has decided that tonight, you’ll eat grated cheese covered thin cut chips; diced normal carrots; juicy large cuts or crispy small cuts of red meat; all drizzled in melted butter, with a small heavy mango for dessert. However, after all these calculations, I’m too tired to make this and will stick with my M&M’s for today. They say baking is a science and cooking is an art but either way, they now both include math.

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