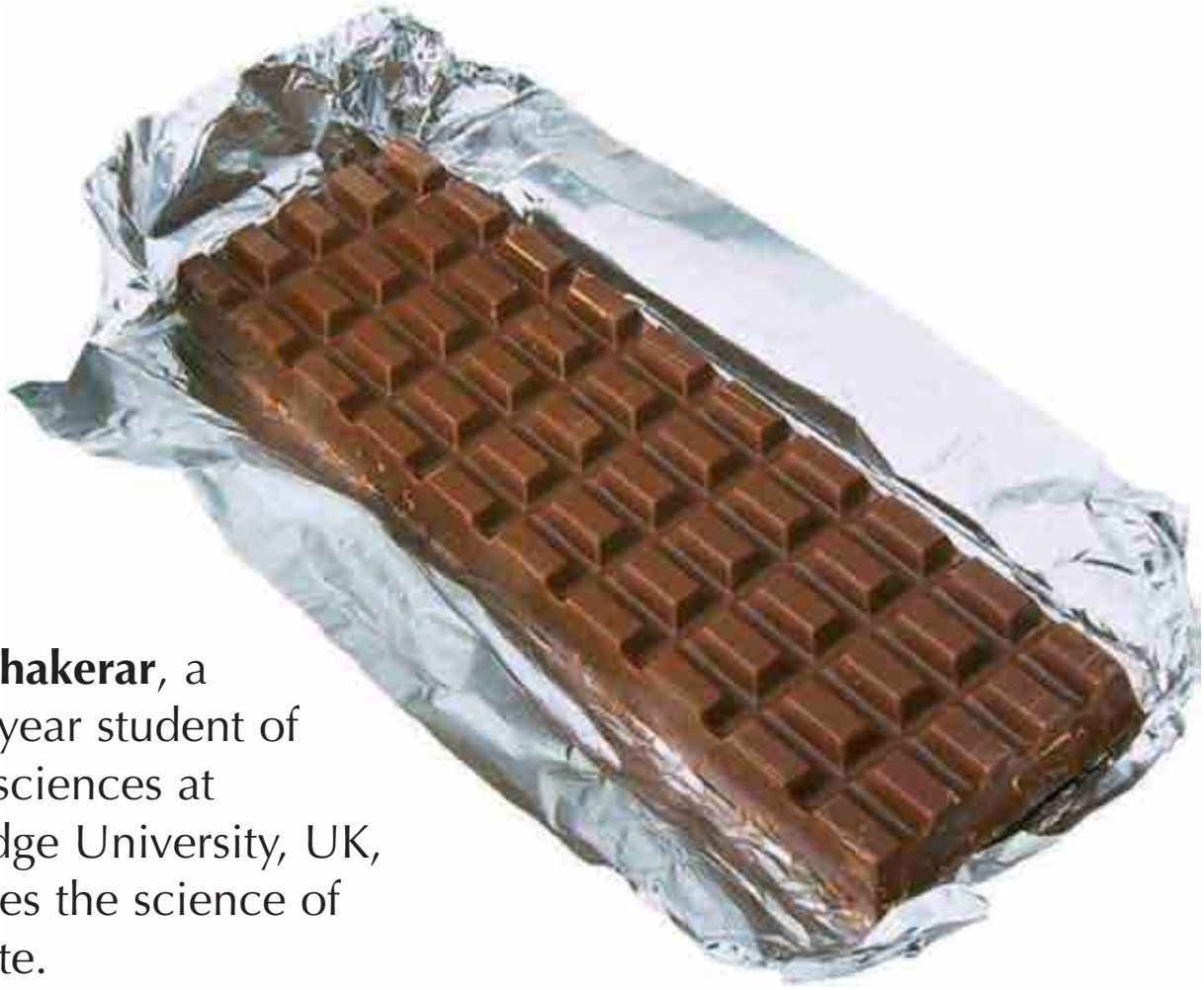
Chocolate's chemical charm



Dhara Thakerar, a second-year student of natural sciences at Cambridge University, UK, elucidates the science of chocolate.

The use of chocolate by humans dates as far back as the Pre-classic period (900 BC to AD 250). Using high-performance liquid chromatography, scientists have discovered cocoa residues in Mayan ceramic pots used in food preparation, dated around 600 BC (Hurst et al., 2002). Numerous Mayan murals and ceramics are inscribed with hieroglyphs depicting chocolate poured for rulers and gods. Perhaps this is not surprising, considering that the Latin name for the cacao tree, *Theobromacacao*, means 'food of the gods'.

When chocolate was introduced to Europe in the 16th century by the Spanish conquistadors, a sweetened version became a luxury item throughout the continent. In 1847, the first commercial chocolate bars were invented in England by Joseph Storrs Fry, with the Cadbury brothers following soon after.

Ever since, chocolate has been absorbed into the fabric of daily life; however, few are familiar with the ways in which it affects our body. The media's message about chocolate remains confusing, as reports alter-

BACKGROUND

Editor's comment

Now that you've grasped the theory of chocolate, it's time for the practical work! See our chocolate-tasting activity on page 29.

nate between scrutinising chocolate for health risks and praising it for hidden health benefits. So, is the mantra of 'eating just a piece a day' more detrimental than beneficial?

The pleasurable feelings that chocolate induces can be explained by its physical properties. Professor John Harwood and his colleagues at Cardiff University believe that the high stearate content of cocoa butter, a key ingredient in chocolate, is responsible for its melting behaviour and stability. Cocoa butter contains between 30% and 37% stearate in its lipid content. As a result, it is solid at room temperature, but when consumed, its fat content absorbs heat from the mouth and melts at body temperature, producing the 'melt in the mouth' effect.

Chocolate has long been suspected of having aphrodisiac properties: the Aztecs thought it invigorated men and made women uninhibited. Consistent with this, the chemical tryptophan is found in chocolate. This is used in the brain to make serotonin, the neurotransmitter that can produce feelings of ecstasy. However, tryptophan is present in chocolate in only small quantities, fuelling debate as to whether it causes the elevated production of serotonin.

Phenylethylalanine, which promotes feelings of attraction, excitement, giddiness and apprehension, has also been isolated in chocolate, but again, its low concentration may be insufficient to produce the effects typically associated with this compound.

Theobromine – a weak stimulant found in chocolate – in concert with other chemicals such as caffeine, may be responsible for the characteristic 'buzz' experienced when eating chocolate. Scientists at the Neurosciences Institute in San Diego suggest that chocolate contains pharmacologically active substances that produce a cannabis-like effect on the brain, such as anandamide: a cannabinoid neurotransmitter (Di Tomaso et al., 1996). Chocolate also contains N-oleoylethanolamine and N-linoleoylethanolamine, which inhibit the breakdown of anandamide, and thus may prolong its effects. In addition, elevated levels of the neurotransmitter can intensify the sensory properties of chocolate (texture and smell), thought to be essential in inducing cravings.

The high fat content of most chocolate – Cadbury's Dairy Milk alone contains 30 g of fat per 100 g – means that excesses can contribute to obesity, which carries with it a range of health risks, including heart disease and diabetes. Nevertheless, not all accusations levelled at chocolate can be justified. The often-touted link between chocolate and acne has been intensively studied for three decades. In a 1969 study at the University of Pennsylvania School of Medicine, 65 subjects with moderate acne ate either chocolate bars containing ten times the amount of chocolate found in a typical bar or identical bars containing no chocolate. Test subjects who consumed the excessive amount of chocolate for four weeks did not show signs of increased acne (Fulton et al., 1969).

Additionally, chocolate has not been proven to contribute to cavities or tooth decay. Cocoa butter may in fact coat teeth and help protect them by preventing plaque formation.

Although the sugar in chocolate contributes to cavities, it does so no more than the sugar in other sweet foods. However, by altering blood flow to the brain and releasing norepinephrine, some chemicals in chocolate can cause migraines.

Perhaps the best compromise is to snack in moderation, particularly on dark chocolate. Not only does it contain more cocoa and proportionally less sugar and fat than milk chocolate, but it is also full of antioxidants called flavonoids. In fact, dark chocolate has been reported to contain more flavonoids than other antioxidant-rich foodstuffs, such as red wine. Flavonoids reportedly prevent cancers, protect blood vessels, promote cardiac health, and counteract mild hypertension (high blood pressure).

Milk chocolate may not offer the same benefits. In one study, patients on separate days ate 100 g of dark chocolate,100 g of dark chocolate with a small glass (200 ml) of whole milk, or 200 g of milk chocolate (Serafini et al., 2003). One hour later, those who ate dark chocolate alone had the highest concentration of antioxidants in their blood, suggesting that the milk in milk chocolate may interfere with the absorption of antioxidants.

Science can explain a number of features that contribute to the lasting popularity of chocolate, although how some of its post-consumption effects occur is still debatable. Although it is unlikely to ever be marketed as a health product, eating the darker varieties and snacking in moderation could prove beneficial. But one thing is certain: from both scientific and sensory perspectives, there is nothing quite like chocolate.

References

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Resources

For more information on the science of chocolate, see the BBC's Hot Topics website: www.bbc.co.uk/science/hottopics/chocolate

Professor John Harwood's research is described here: www.cf.ac.uk/biosi/research/molecular/staff/harwood.html

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REVIEW

Mmm...chocolate! Everybody loves it. And it is potentially good for you; that is, of course, if it is dark and in small quantities. This is what the short but highly interesting and enlightening article by Dhara Thakerar suggests, citing scientific evidence to support her case.

Although the details of the chemical substances in chocolate might be beyond the secondary school level, their effects on the body and health can be easily understood and appreciated. This article can thus be directly used in any science class to inform students about the advantages and disadvantages of eating chocolate. Furthermore, biology and chemistry teachers might find the article suitable for a discussion on how a single type of food can be either beneficial or harmful depending on how, by whom and for what purposes it is used. In fact, a debate could be carried out with groups of students acting as proponents or opponents of the habit of eating chocolate.

Finally, if the theoretical treatment of the subject is considered insufficient and needs practical investigation, all the teacher has to do is to take a box of dark chocolate into the classroom...

Michalis Hadjimarcou, Cyprus