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NewScientist

WEEKLY 18 July 2009

MOON ROCK
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These burgers are identical...

...but one will make you fatter

Not all calories are created equal

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fiction

Nutrition Facts

Amount per Serving

Calories 150 Calories from Fat 70

?

	% Daily Value*
Total Fat 7g	11%
Saturated Fat 1.5g	6%
Cholesterol 0mg	0%
Sodium 120mg	5%
Total Carbohydrate 20g	7%
Dietary Fiber 4g	15%
Sugars 9g	
Protein 1g	

*** Percent Daily Values are based on a 2,000 calorie diet. Your daily values may be higher or lower depending on your calorie needs:**

	Calories	2,000	2,500

Calories per gram:

Fat 9 • Carbohydrate 4 • Protein 4

The calorie delusion

Your food doesn't do exactly what it says on the label, **Bijal Trivedi** discovers

STANDING in line at the coffee shop you feel a little peckish. So what will you choose to keep you going until lunchtime? Will it be that scrumptious-looking chocolate brownie or perhaps a small, nut-based muesli bar. You check the labels: the brownie contains around 250 kilocalories (kcal), while the muesli bar contains more than 300. Surprised at the higher calorie count of what looks like the healthy option, you go for the brownie.

This is the kind of decision that people watching their weight – or even just keeping a casual eye on it – make every day. As long as we keep our calorie intake at around the recommended daily values of 2000 for women and 2500 for men, and get a good mix of nutrients, surely we can eat whatever we like?

This is broadly true; after all, maintaining a healthy weight is largely a matter of balancing calories in and calories out. Yet according to a small band of researchers, using the information on food labels to estimate calorie intake could be a very bad idea. They argue that calorie estimates on food labels are based on flawed and outdated science, and provide misleading information on how much energy your body will actually get from a food. Some food labels may over or underestimate this figure by as much as 25 per cent, enough to foil any diet, and over time even lead to obesity. As the western world's waistlines expand at an alarming rate, they argue, it is time consumers were told the true value of their food.

Calorie counts on food labels around the world are based on a system developed in the late 19th century by American chemist Wilbur Olin Atwater. Atwater calculated the energy content of various foods by burning small samples in controlled conditions and measuring the amount of energy released in the form of heat. To estimate the proportion of this raw energy that was used by the body, Atwater calculated the amount of energy lost as undigested food in faeces, and as chemical energy in the form of urea, ammonia and organic acids found in urine, and then he subtracted these figures from the total. Using this method, Atwater estimated that carbohydrates and protein provide an average of 4 kcal per gram, while fat provides 9 kcal per gram. With a few modifications, these measurements of what is known as metabolisable energy have been the currency of food ever since.

We know these values are approximate. Nutritionists are well aware that our bodies don't incinerate food, they digest it. And digestion – from chewing food to moving it through the gut and chemically breaking it down along the way – takes a different amount of energy for different foods. According to Geoffrey Livesey, an independent nutritionist based in Norfolk, UK, this can lower the number of calories your body extracts from a meal by anywhere between 5 and 25 per cent depending on the food eaten. "These energy costs are quite significant," he says, yet are not reflected on any food label.

Dietary fibre is one example. As well as being more resistant to mechanical and chemical digestion than other forms of carbohydrate, dietary fibre provides energy for gut microbes, and they take their cut before we get our share. Livesey has calculated that all these factors reduce the energy derived from dietary fibre by 25 per cent – down from the current estimate of 2 kcal per gram to 1.5 kcal per gram (*The American Journal of Clinical Nutrition*, vol 51, p 617).

Similarly, the number of calories ›

attributed to protein should be reduced from 4 kcal per gram to 3.2 kcal per gram, a 20 per cent decrease, Livesey says. That's because it takes energy to convert ammonia to urea when protein is broken down into its constituent amino acids (*British Journal of Nutrition*, vol 85, p 271).

Put into the context of real life, these relatively small errors may make a measurable difference. In the case of the brownie versus the muesli bar, the label will overestimate the calories derived from the fibre and protein-packed muesli bar, perhaps by enough to make it lower in calories than the brownie. Just 20 kcal per day more than you need can add up to roughly a kilogram of fat over a year.

Errors in the Atwater factors for protein and fibre are just one reason why the brownie may pack more of a calorific punch than the label suggests. The brownie will be much softer in texture than the nut-bar, a factor that is known to lower the energy cost of digestion. In a study published in 2003, for example, a team led by Kyoko Oka at Kyushu University in Fukuoka, Japan, investigated the effect of food texture on weight gain. They fed one group of rats their usual hard food pellets, while a second group received a softer version. Both pellets had exactly the same calorie content and flavour. The only difference was that softer ones were easier to chew. After 22 weeks, the rats on the soft food diet were obese and had more abdominal fat. "Food texture might be as important a factor for preventing obesity as taste or food nutrients," Oka and his colleagues concluded (*Journal of Dental Research*, vol 82, p 491).

A similar study in people had comparable results. Kentaro Murakami and Satoshi Sasaki, both at the University of Tokyo in Japan, surveyed 450 female students about their eating habits and then classified the food they ate according to how difficult it was to chew. They found that women who ate the hardest foods had significantly slimmer waistlines than those who ate the softest foods (*American Journal of Clinical Nutrition*, vol 86, p206).

What's more, the brownie is made from refined sugar and flour, making it easier for our bodies to extract the available calories than it would be from the complex carbohydrates of the oatmeal in the cereal bar. And while the Atwater system assumes that the proportion of food that passes through the gut undigested is more or less constant, at around 10 per cent, we have known for more than 60 years that this is not the case. Thirty per cent or more of coarse-ground wheat flour may be excreted, while today's finely milled flours may be almost completely digested. As a result, foods made from these fine flours – like that brownie – are likely to channel practically all of the energy from carbohydrate into the body.

Cooking, too, can affect how many calories the body gets from foods, another factor the Atwater system ignores, says Richard Wrangham, a biological anthropologist at Harvard University. Wrangham became interested in the impact of food processing on calorie availability as part of his work into how cooking affected human evolution. In his recently published book *Catching Fire: How cooking made us human*, Wrangham suggests that the advent of cooking propelled our ancestors onto the evolutionary fast track, by providing more energy to invest in growing bigger brains.

"Just 20 kcal per day more than you need can add up to roughly a kilogram of fat over a year"

"Cooking gives food energy," says Wrangham. It alters the structure of the food at the molecular level, making it easier for our body to break it up and extract the nutrients.

In plants, for example, much of the energy from starch is stored as amylopectin, which is semi-crystalline, does not dissolve in water, and cannot be easily digested. Heat starchy foods with water, though, and the crystalline forms begin to melt. The starch granules absorb water, swell, and eventually burst. The amylopectin is shattered into short starch molecules called amylose, which are easily digested by the enzyme amylase.

Cooking also makes meat more digestible. Proteins are like origami – complex, folded, three-dimensional structures that stomach acids and enzymes can't easily access. Heat unfolds the proteins, exposing them to enzymes that chop up the amino acids so they can be recycled into proteins the body needs.

To explore how much cooking ramps up the caloric potential of food, Wrangham teamed up with Stephen Secor, an expert in the physiology of digestion at the University of Alabama, Tuscaloosa. Secor tested the impact of cooking and grinding food on the ability of Burmese pythons to digest and absorb the nutrients. Pythons may sound like a strange choice, but they are useful models for studying digestion because they remain motionless for days after eating, making it easy to link changes in metabolism to the food they have eaten.

Secor fed the snakes one of four options: intact raw steak, intact cooked steak, ground raw steak or ground cooked steak. He found that cooking or grinding the meat reduced the cost of digestion by 12.7 per cent and 12.4 per cent respectively. When he fed the pythons steak that had been both ground and cooked, the combination lowered the amount of energy needed to digest the meal by 23.4 per cent.

"That's a significant decrease in the cost of digestion," says Secor. "It means that there are that many more calories that can be allocated to other activities, like glucose or fat storage."

In other experiments Secor tested the energy differences between cooked and raw carrots when fed to bearded dragons. Unlike pythons these lizards are omnivorous, which makes it possible to test the response of the digestive system when raised on a strictly herbivorous, carnivorous or omnivorous diet. By counting the number of chews the dragons took before swallowing the food, his preliminary findings suggest that the cooked carrots require only about half as many chews as the raw vegetable, which corresponds to more than a 40 per cent drop in the energy needed to chew.

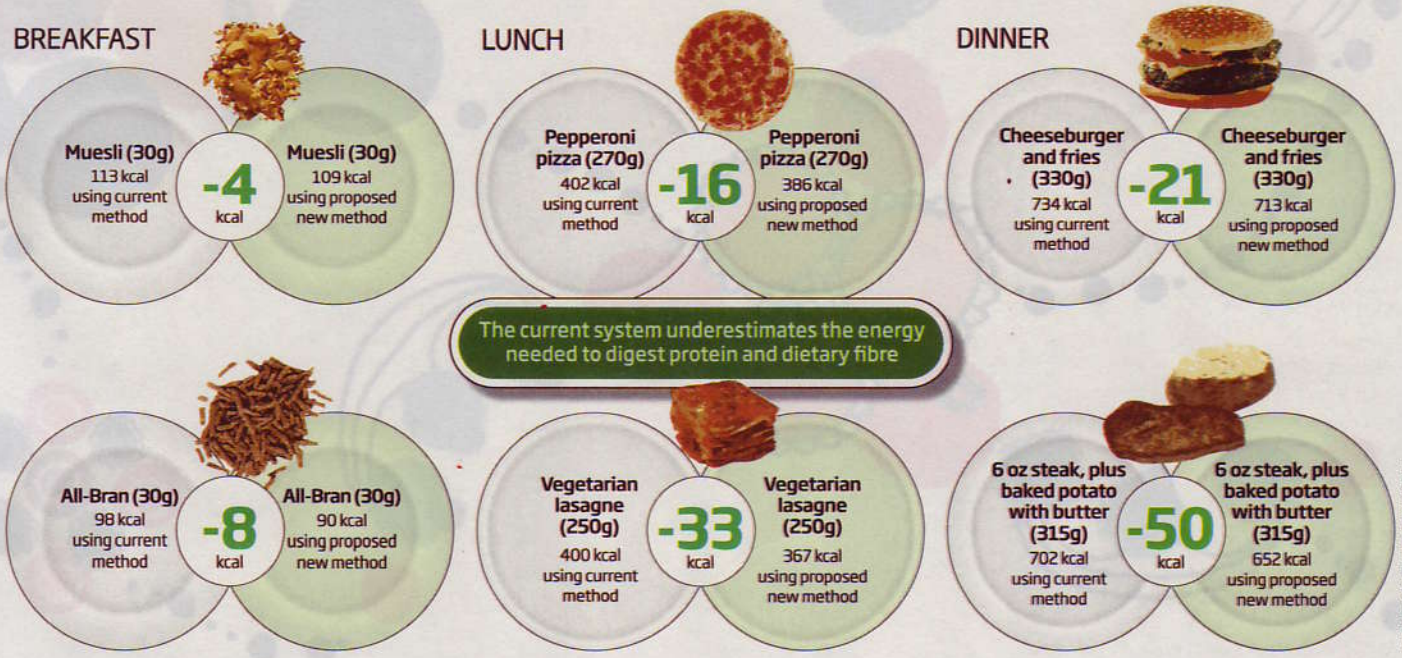
A handful of human studies supports what has been discovered in animals. In the late 1990s, Pieter Evenepoel, now at University Hospital Leuven, in Belgium, labelled egg protein with radioactive isotopes and tracked it as it passed through the digestive tracts of human volunteers. One experiment involved giving 25 grams of cooked egg protein to five volunteers who had undergone an ileostomy, in which a loop of the small intestine is

DAN SAELINGER/IMAGE BANK

Having it medium rare might just save you some calories

WHEN CALORIES COUNT

Low-calorie food options become more obvious when you use a proposed new system (net metabolisable energy, or NME) to estimate the calorific value of foods as this takes into account the energy needed to digest them



SOURCE: GEOFFREY LIVESEY, NLOGIC LTD

brought to the surface and faeces are collected in a bag. Later they gave the patients the same meal but this time the egg was raw. After the meals, the contents of the bag and the breath of the patients were examined for labelled nitrogen and carbon – the remnants of the digested protein. They found that 90 per cent of the cooked egg was digested compared to just 51 per cent of the raw egg (*The Journal of Nutrition,* vol 128, p 1716).

Yet despite these large variations in how much energy the body has at its disposal either to use or store, none of this is reflected in the food labelling system, which some say leaves the consumer in the dark about their dietary choices. "It's difficult to produce a meaningful, accurate estimate of the impact of food processing, so people have simply pushed that question aside... so far aside that most people in the public aren't even aware of it," says Wrangham.

So if food labels are giving consumers a potentially misleading picture of their dietary choices, what should be done about it?

For many nutritionists, the answer is nothing. While they acknowledge that the current system isn't perfect, many argue that sticking with the Atwater system makes it easy to calculate a ballpark calorie count. They also say that overhauling such a widely used system would require a huge amount of research in both animal models and human volunteers, plus a more complicated labelling system than consumers are used to, for little real public health benefit. "There will be errors, but not very serious errors, and nobody can do their calories anyway so what difference does it make?" says Marion Nestle, a nutritionist at New York University.

Calorie recount

Indeed, back in 2002, the UN Food and Agriculture Organization (FAO) assembled an international group of nutritionists, including Livesey, to investigate the possibility of recommending a change to food labelling standards to reflect the cost of digestion. The group, with the exception of Livesey, decided to stick with metabolisable energy for calculating nutrition labels on food products because, the report concluded, "the problems and burdens ensuing from such a change would appear to outweigh by far the benefits".

"We believe that metabolisable energy is a more accurate representation of what's in that food for everybody [and is] more accurate for the purposes of food labelling," says Janis Baines, a nutritionist at the regulatory agency Food Standards Australia New Zealand, in Canberra, who supports the FAO's decision.

Livesey, however, is convinced that the Atwater system needs to be revised to take into account the energy used to digest different foods – to provide updated values for protein and dietary fibre that reflect the cost of digestion.

Wrangham agrees, and suggests that in addition to making calorie counts more accurate for different foods, there could be a system describing roughly how many calories would be gained if you cooked a particular food in different ways. A steak, for example, may provide more available calories per serving if cooked well done, than if done medium-rare or served raw.

Even Livesey would not expect these adjustments to solve the obesity crisis, at least not on their own. Nevertheless, he believes correcting food labels to reflect the latest science will give the diet-conscious consumer the information they need to make the best kinds of dietary choices based on the latest scientific understanding of digestion. "The public should be able to apply the science," he says. "[And] if you're not following the science you're following something else". ■

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