It's supposed to be lean cuisine. So why is this chicken fatter than it looks?

We think of chicken as the healthy option for our Sunday roast, but even organic or free-range birds lack the protein and nutrients of a generation ago, reports Andrew Purvis - and the veg ain't what it used to be either

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It is, on the face of it, the opposite of junk food - a low-fat chicken (long promoted as a healthy alternative to red meat) brushed with olive oil and roasted, with no chemical additives, no batter, no breadcrumbs, no smiling Colonel Sanders and no Happy Meal toy. Last month, however, Britain's favourite bird was shown to contain as much fat, gram for gram, as a Big Mac. Professor Michael Crawford and Yoqun Wang of London Metropolitan University found that a chicken in 2004 contained more than twice as much fat as in 1940, a third more calories and a third less protein - when protein is what the consumer is paying for. As Professor Crawford says, 'We now need a new definition of what we mean by a healthy food.'

For the first time since records began inthe 1870s, the fat in a Sunday roast outweighs its protein by a factor of 1.4. Today, a 1.3kg supermarket bird leaves behind 275g of fat in the roasting tin and, of the remaining lean, four-fifths is water (though this is determined by cell biology and has not changed since 1940). 'When people see this, they begin to realise that food is not as cheap as they think it is,' Professor Crawford says. 'Six times as many calories are coming from fat as from protein, you are being sold a pup down the line.' Even organic chickens, assumed to be a healthier option, contain only slightly less fat (17.1g per portion) than protein. It may have had more space to roam than a conventionally reared bird but is still given high-energy feed, takes little exercise and is bred for rapid weight gain, when the development of meat takes time. 'A free-range bird is the best,' says Crawford, 'but even that depends on its diet.'

In 50 years, poultry has gone from being a health food to a junk food - and some scientists claim other natural produce is going the same way. Last month, delegates at the conference Overfed and Undernourished (organised by BANT, the British Association of Nutritional Therapy) heard that, between 1940 and 1991, many fresh fruits and vegetables had lost large amounts of minerals and trace elements.

David Thomas - a geologist turned chiropractor (who also happens to sell mineral supplements) - analysed data from McCance and Widdowson's epic work, The Composition of Foods (a reference manual republished and updated by Government biochemists every few years). During that 51-year period, potatoes appeared to have lost 47 per cent of their copper, 45 per cent of their iron and 35 per cent of their calcium while carrots showed even bigger declines. Broccoli - a 'superfood' rich in micronutrients and cancer-busting antioxidants - suffered an 80 per cent drop in copper while calcium content was a quarter of what it had been in 1940, a pattern repeated in tomatoes. As Thomas pointed out: 'You would need to have eaten 10 tomatoes in 1991 to have obtained the same copper intake as from one tomato in 1940.'

His theory, largely unproven, is that modern horticulture methods such as hydroponics (growing fruits and vegetables in irrigated matting rather than soil) and chemical fertilisers, together with new varieties of crop, longer storage times and long-distance transport, may havecaused changes in the nutritional value of the foods we eat.

In a recent talk, he presented charts (based on US government figures) suggesting a correspondence between increases in deficiency disease (cardiovascular problems, asthma, bronchitic and orthopaedic deformities) and declining levels of magnesium in the US diet - specifically tomato, lettuce, cabbage and spinach. 'I'm convinced mineral depletion is part of our current health crisis and increase in lifestyle diseases. I'm not saying it's the whole problem - but if we want to be happier and healthier, we have to understand we are part of the environment and not separate from it. A significant part of that environment is our food, and that is declining in quality over time,' says Thomas.

Professor Richard Mithen, head of phytochemicals and health at the Institute of Food Research (IFR), disagrees. 'I don't want to be unduly negative about David Thomas's work,' he says, 'but it is merely anecdotal; it doesn't stand up to analysis. In 50 years, mineral levels will have changed due to di. erent agronomic practices. We use different fertilisers now, we have different pollution which may have an effect. Some of these minerals may have gone down, others will have gone up. However, the health implications of this are not at all apparent.

OK, potassium levels have declined in leafy vegetables - but so what? People eat

bananas now, which are rich in potassium - and how many of those would they have eaten in the 1940s? Carrots may have lost 46 per cent of their iron but they are not a good source of iron in the diet anyway. It's better to eat liver.' Minerals in vegetables may be an irrelevance, but what about vitamins? In 2002, the Toronto Globe and Mail reported that fruit and vegetables bought in Canadian supermarkets had shown marked declines over a 50-year period. Analysing food tables prepared by government scientists between 1951 and 1999 (roughly as David Thomas had done), researchers found that potatoes had lost 100 per cent of their vitamin A (important for good eyesight) and 57 per cent of their vitamin C, while today's consumers would have to eat eight oranges to get the same amount of vitamin A as their grandparents obtained from one fruit.

Professor Mithen of the IFR says the same false logic is evident in these Canadian claims as in David Thomas's. 'It may be true that you need to eat six,' he says, 'but my children eat far more oranges now than my grandparents ever did. It all has to be looked at in the overall context of how our diet has changed.' Last year, a study of 43 vegetables and fruits published in the Journal of the American College of Nutrition found significant declines for six nutrients (protein, calcium, phosphorous, iron, riboflavin and ascorbic acid) between 1950 and 1999. Comparing old and new figures from the US Department of Agriculture, Donald Davis, author of the University of Texas study, concluded that changes in cultivated varieties, rather than horticulture practices, accounted for the depletion. 'In those 50 years,' he said, 'there have been intensive efforts to breed new varieties that have greater yield, or resistance to pests, or adaptability to different climates - but the dominant effort is for higher yields. New evidence suggests that, if you select for yield, crops grow bigger and faster but they don't have the ability to make or uptake nutrients at the same rate.'

So far, so academic - does any of this matter? Even if Davis's analysis is correct, there is no evidence that nutrient deficiencies in crops are making human beings ill. Indeed, such are the known health benefits of eating plenty of fruit and vegetables (as outlined in the Government's Five-a-Day campaign and the World Health Organisation's directive for beating cancer), any reduction in mineral content is massively outweighed by the health-giving vitamins, minerals, fibre, phytochemicals and micronutrients that were abundant in the plant-based diets of our ancestors. 'It is more an issue of consumer rights,' says Tim Lang, professor of food policy at City University, London. 'We think of something like an orange as a constant, but it isn't.' Professor Phil Warman of Nova Scotia Agricultural College in Canada expressed a similar view when the Toronto Globe and Mail published its story. 'I want to eat a product that is as high in nutritional value as possible,' he said, 'otherwise I'd just eat sawdust with nitrogen fertiliser.'

However, Lang and Warman's ethical argument is invalid if the methodology of such historical comparisons is flawed. Critics say analytical techniques have changed since the 1950s, the original US government figures may have been wrong and all kinds of variables could have changed.

The same criticisms were levelled at David Thomas's work, but Professor Michael Crawford (co-author of the chicken study) says this is a red herring. 'The traditional methods used by physical chemists are still the most accurate on the planet for measuring weights and components,' he says. 'What has changed is not the accuracy of the methodology but the peripheral stuff - like linking it to a computer and being able to do 300 measurements in an hour. It's wrong to say people measuringcopper in the 1940s were measuring something different.'

Studying The Composition of Foods, I can see why this kind of analysis leaves plenty of room for error. Its dense rows of tabulated figures are littered with footnotes as the compilers struggle to incorporate new food knowledge into old. Some results are listed as ranges rather than single figures because there are so many variables - how long a broccoli sample was boiled (15 minutes in 1991, a staggering 45 minutes in 1940) and the length of time a crop was stored. One addendum says, 'Fresh dug potatoes contain 21mg of vitamin C per 100g. This falls to 9mg per 100g after three months' storage and to 7mg after nine months' storage' - appearing to support David Thomas's claim that some modern agricultural practices may be compromising nutritional value.

In fact, the most worrying deficiency in the British diet has nothing to do with storage times, transport methods or the farmer's alleged obsession with higher yield. It is caused by the natural idiosyncrasies of our soil - something David Thomas, as a geologist, overlooked. 'Since the 1970s,' says Professor Richard Mithen of the IFR, 'the selenium in our blood plasma has gone down and is currently half the recommended intake. This is very well documented, and we know that selenium levels are very important for maintaining health.' Deficiency in selenium may be linked to infertility, depression, heart disease and increased risk of some cancers, including prostate, colon, lung and breast cancers.

From the 1940s to the 1960s, Professor Mithen adds, we imported all our bread wheat from Canada and the US; British varieties were good for making biscuits but not much good for making bread. 'At that time,' he says, 'we had a very good plant breeding industry, a lot of it government-controlled. They bred new wheat varieties for the UK and were very successful, so in the 1970s we stopped importing wheat because we could grow it ourselves.' One consequence was that the wheat grown in Britain had only about a quarter of the selenium content of imported wheats, due to lower levels in the soil. 'It's

a very real concern,' says Mithen, 'but we are now addressing that.'

The Food Standards Agency is funding a project at the IFR, looking at the role of selenium in immune function in human volunteers. 'The effects of eating selenium, either in supplement form or in selenium-rich food such as onions, will be studied,' says Dr Rachel Hurst of the IFR. 'It is vitally important to understand how much and which type of selenium would offer most health benefits and to find ways of increasing selenium in the foods we eat.' In the meantime, Waitrose is selling a selenium enriched bread grown by a farmer in East Anglia who fertilises his soil with selenium. In Finland, the government introduced a policy in the 1990s of fertilising all agricultural land after experiencing the same problems as Britain. 'Nobody could have anticipated what would happen with selenium,' Professor Mithen says. 'It makes you wonder what else we are doing in our food production system now that we can't predict.'

Gundula Azeez, policy manager for the Soil Association, thinks she knows. She cites a (disputed) 2001 review study, published in the Journal of Alternative and Complementary Medicine, showing that nutrient levels, including vitamin C, are lower in crops grown with chemical fertilisers. Organic spinach, lettuce, cabbage and potatoes showed relatively high levels. 'Unlike minerals, vitamins and antioxidants are not supplied by the soil,' she says, 'so you cannot add them using fertilisers. They are produced by the plants themselves and are natural pest-defence compounds, part of a range of chemicals we are just beginning to understand. Studies have shown that levels are up to 40 per cent higher in organic produce. If you're using artificial pesticides, plants don't have to produce these protective chemicals. Levels in non-organic foods are likely to be lower.'

However, the Food Standards Agency maintains there are no clear nutritional or health benefits of organic food over conventional and that further research is needed. Azeez claims this research is 'now coming out', suggesting one further impact of chemical fertilisers on the composition of plants. 'Studies show that organic food has 15 per cent more dry matter than non-organic food,' she says, 'so for each kilo of organic fruit or veg you are getting 15 per cent more nutrition. Some of the high yield in conventional farmed crops is just water. By using a lot of NPK [nitrogen phosphorous potassium] fertilisers, the plant is forced to grow faster - and our measure of growth is just the weight at the end. There is no focus on what growth really means in plants and animals. With livestock, too, you are giving them unnaturally high-energy diets to force them to grow a lot faster.'

In the past, according to the 1996 book Food Ethics, it took a steer more than six years to reach a body weight of 500kg; now, it takes an unnatural 20 months. A dairy cow

produces 9,000kg of milk per year compared with 2,000kg in 1956. In a pattern pertinent to Professor Michael Crawford's work, a 2kg broiler chicken is now produced in six or seven weeks instead of 14. Can such rapid growth really be sustained without a loss of meat quality? Professor Crawford believes it can't.

'This whole focus on rapid growth, achieved through a high-energy, cereal-based diet has changed the lipid composition of the chicken meat itself,' he says, 'and you cannot escape that - even by removing the skin and scraping away the subcutaneous fat stuck to the meat.' As evidence, he shows me slides of meat taken from a wild African buffalo (eating a natural grass-based diet) compared to that of a domestic beef animal. When stained with red dye and examined under a microscope, the first looks uniform and fibrous while the second is striated with ridges and ripples of white lard. 'That pattern is the fat infiltrating between the muscle fibres that have died, or atrophied, as a result of lack of exercise when the animal is immobilised in stocks in the final finishing stage. It's known as "pathological fat infiltration" - which most of us refer to as marbling.'

I ask whether marbling is what gives meat its flavour, a story I have heard from chefs. 'I would contest that,' says Professor Crawford, who turns out to be a wild meat connoisseur. 'The roast pig sold in the market in Perugia comes from the woods and is out of this world in flavour and texture,' he says. 'It was the next best thing to the warthog we ate in East Africa. The texture of that was so firm that you could slice it thin with a razor. The flavour was exceptional.' With diffculty, I lure him out of his reverie and ask whether marbling ever occurs naturally. 'You would never get anything like that in a wild animal,' he says, 'or even domestic cattle that are allowed to run out in the wild by the Masai in Africa. They eat a natural grass-based diet.' By comparison, domestic livestock overdose on cereal-based feed and have historically been fed everything from animal droppings to other animals. Beef tallow, the fat trimmed from cattle carcasses, is still used in the United States to boost the calorific value of chicken feed. 'The whole idea is that, if you have a pound of beef fat in the chicken feed, you get a pound of weight gain in the animal,' Professor Crawford says.

By feeding beef tallow back to beef cattle, the industry is underlining the dangers of placing rapid weight gain and profit over responsible animal husbandry. That, after all, is how BSE began. In Britain, there is no evidence that beef tallow still goes into animal feed but artificial, high-energy diets are a concern. 'As we demonstrated with fatty chicken,' Professor Crawford says, 'feed is one factor in this enormous disproportion in the calorific value coming from protein and the calorific value coming from fat. That fat has to go somewhere.' In his view, the current obesity epidemic in the West, with its knock-on effect on coronary heart disease, type 2 diabetes and other lifestyle illnesses, is

the result. We are becoming obese, he maintains, because we are eating obese farm animals.

In the case of chicken, this undermines previous health advice. In 1976, the Royal College of Physicians and the British Cardiac Society recommended that we eat less red meat (high in saturated fats) and substitute it with lean poultry in an effort to halt heart disease. As a result, chicken consumption in Britain has doubled, with each of us consuming almost 30kg per year.

Recent fears about cheap foreign imports, battery farming, campylobacter food poisoning and chicken carcasses adulterated with beef protein to make them absorb water (cheating the consumer) have slightly dented sales - but chicken is still seen as a healthy option. Brigid McKevith, a scientist at the British Nutrition Foundation, believes we should still eat it if prepared in the right way. 'A roast chicken is fine once in a while,' she says, 'but it's a good idea to pour off extra fat and remove the skin.' With his intimate knowledge of chicken anatomy, Professor Crawford disagrees, believing the high level of saturated fat in chicken is a recipe for heart disease.

In his view, however, there is a far more important human health risk inherent in the diet fed to livestock. 'Our physiology is adapted to eating wild food,' he says, 'but that is not what we are getting with today's animals.' A 100g portion of chicken in 2004 contained just 25mg of DHA - a long-chain omega-3 fatty acid, now known to be good for the heart by suppressing 'thrombotic' tendencies - compared to 170mg in 1980. (In our year of comparison, 1940, DHA content was not analysed.) At the same time, levels of linoleic acid - an omega-6 fatty acid, essential for brain development and other important functions but having a 'pro-inflammatory' effect opposite to that of the omega-3s - had risen to 6,290mg per 100g portion compared to 2,400mg in 1980, some 2.6 times the amount.

Why do these proportions matter? 'During human evolution, the ratio of omega-6 to omega-3 fatty acids in the diet was probably something like 1:1,' says Dr Alex Richardson, senior research fellow at the University Laboratory of Physiology, Oxford. 'These days it is more like 15:1 in favour of the omega-6s.' By eating animals with even higher ratios - 20:1 in the meat of a farmed pig, compared to 3:1 in a wild warthog - plus an unnatural amount of cereal-based foods (which are high in omega-6), we are altering or natural diet and risking chronic illness.

In 1978, the WHO recommended a ratio of 5:1 or less in the general diet; the optimum target for brain development, it said, should be 2:1 at the most, achieved by eating more oily fish, fewer cereals and less milk and meat. Current ratios are nothing like that.

Correcting this, Crawford says, would require 'a revolution in the animal industry' because all livestock is fed cereals. 'Animal husbandry started with grass and green foods,' he says, 'which are rich in omega-3. That is the beauty of fish and seafood because it's still largely wild, it's still living in an omega-3-rich environment. The same used to be true of livestock animals - even chickens used to roam free and live off seeds and herbs - but that is no longer the case. It really is a question of redesigning our food and agriculture systems so they are more keyed in to the pivotal priority of human physiology - namely, our original genome being shaped by wild foods.'