Coffee drinking, past and present

The consumption of caffeine-containing drinks such as tea and coffee dates back at least 1,000 years in the East and the first recorded commercial cultivation was in the fifteenth century in Ethiopia. By the end of the seventeenth century coffee drinking and coffee houses had spread throughout Europe, including in Britain where these establishments became important meeting places and centres of commerce, especially in the City of London, where some developed into famous institutions such as the Stock Exchange and Lloyd’s. Today coffee is big business with worldwide consumption averaging 3.6 million tonnes in the 1990s (International Coffee Organisation, 1998). Europe consumes the most coffee, followed by North and Central America. Two important twentieth century developments have been the manufacture of instant coffee and decaffeinated coffee (Debry, 1994). Instant coffee is made by spray- or freeze-drying a coffee brew to remove the water, leaving a powder or granules which can be reconstituted. Commercial decaffeination processes are based on extraction with water, carbon dioxide or organic solvents. Today the major UK coffee manufacturers use either the water or carbon dioxide methods and solvent decaffeination is used to a much lesser extent than in the past. The types of solvent used for decaffeination are governed by both national and European legislation; they include methylene chloride (dichloromethane) and ethyl acetate, which is a natural component of fruits and other foodstuffs. Under European law, methylene chloride residue levels must be under two parts per million. All methods remove about 97-98 per cent of the caffeine at the green bean stage, before roasting, and therefore do not affect aroma development.

In Britain, coffee sales grew by 32 per cent between 1992 and 1997, overtaking tea in 1993, and now there is something of a coffee drinking revolution under way with US-style coffee bars becoming a familiar sight on Britain’s high streets, and coffee carts and bars, offering an amazing choice of speciality coffees, springing up at stations, in shopping centres, and in bookshops. On average in Britain we drink three cups of tea and just under two cups of coffee daily, compared with eight to nine cups of coffee in Scandinavia and four cups in the USA. Instant coffee still accounts for 85-90 per cent of all coffee drunk.
in Britain and we are still fairly traditional, preferring to drink tea at breakfast and in the afternoon and coffee during the morning. In contrast, almost all the coffee drunk in Scandinavian countries is brewed from the roasted and ground bean.

The composition of coffee

Although there are about 50 different species of coffee, only two are used for world-wide commercial cultivation: varieties of Coffea arabica (arabicas) and of Coffea canephora (robustas). The composition of coffee is complex and depends on the species and variety of green coffee and on its commercial and domestic handling; it has been reviewed in detail by Debry (1994). Coffee contains more than two thousand different components, some in minute amounts, including carbohydrates, fats, protein and other nitrogenous substances, notably caffeine, minerals, notably potassium, some B group vitamins, various acids which influence the organoleptic properties of brewed coffee, and more than 700 volatile compounds, many of which also influence coffee aroma and pigmentation.

Caffeine

Caffeine is the major pharmacologically active ingredient in coffee. Since the discovery of its chemical structure in 1895 (see Debry, 1994), caffeine has become one of the most extensively studied food ingredients. The chemical structure of caffeine (1,3,7-trimethylxanthine) is shown in Figure 1. It is one of a group of plant alkaloids and occurs naturally in the leaves, seeds and fruits of more than 60 plant species, including coffee, tea, cocoa and cola and is therefore present in the beverages made from these substances, as well as in chocolate. Caffeine is present in various soft drinks.

Figure 1 The structure of caffeine (1,3,7-trimethylxanthine)
whether it is filtered, percolated, expresso, cafetière or instant, and because arabica beans have about half the caffeine content of robusta beans, on the variety and blend of the coffee as well. With tea, the variety and blend will also influence caffeine content.

The physiological effects of caffeine and coffee

Following ingestion, caffeine is readily absorbed from the gut and does not accumulate elsewhere in the body as it is rapidly metabolised by the liver and eliminated. It has an average half-life of approximately four hours, although there is a tremendous individual variation in metabolism and estimates vary between two and ten hours (Debry, 1994). Smokers metabolise caffeine more quickly than non-smokers, and metabolism is slowed down during pregnancy, especially during the latter stages.

It is well-documented that caffeine is a mild stimulant, acting on the central nervous system (CNS) and that it can increase metabolic rate. Its primary mode of action as a CNS stimulant is related to its role as an antagonist of adenosine receptors in the brain, again discussed in detail by Debry (1994). Various studies have shown that the stimulant effects are beneficial and that the consumption of an amount of caffeine equivalent to that found in two cups of coffee can improve alertness and enhance concentration. For example, a cup of coffee after lunch has been shown to counteract the “post-lunch dip” in concentration (Smith et al., 1990). Research on night shift workers has clearly demonstrated a beneficial effect on alertness and performance of a variety of tasks and it is suggested that caffeinated coffee is beneficial to shift workers in helping to maintain attention, thereby reducing the likelihood of industrial accidents (Smith et al., 1993; Walsh et al., 1990). Studies investigating driver sleepiness (estimated to account for one in five road accidents) indicate that two cups of coffee and a ten minute nap are the most effective solutions (Reyner and Horne, 1997; 1998).

Habituation

It has been suggested that drinking caffeinated coffee on a regular basis may indicate some degree of habituation or "addiction”. However, there is no evidence that regular consumers gradually increase the amounts of coffee consumed or exhibit signs of decline in social behaviour normally associated with a classic drug dependence. The American Psychiatric Association (1987) does not recognise caffeine dependence or abuse as diagnostic categories of psychoactive substance use disorder and the International Classification of Diseases (1980) does not include caffeine as a drug of dependence or abuse. The existence of caffeine withdrawal symptoms has prompted continuing, but unresolved, debate concerning whether caffeine dependence should be recognised as a clinical syndrome (Heishmann and Henningfield, 1994; Strain et al., 1994). A sudden reduction or total abstention by regular caffeine consumers can lead to mild withdrawal symptoms, such as headache and lethargy in a minority of people, but most people suffer no adverse effects. However, if for some reason it is necessary to reduce the intake of caffeine-containing beverages, a gradual reduction over a number of days is advisable.
Coffee and health

Over the years there have been numerous health scares concerning caffeine and coffee, but despite a vast amount of research, the evidence to support most of these is limited. Furthermore, the strong positive correlation between the consumption of coffee, tobacco and alcohol, and even inactivity, may sometimes confuse the picture presented by epidemiological studies and must be properly taken into account in their interpretation (D’ebry, 1994). This is particularly relevant in relation to the debate about coffee drinking and cardiovascular disease (CVD) and its recognised end points of myocardial infarction and cardiac arrhythmias and the risk factors of hypertension and raised blood cholesterol.

The consensus of published literature provides little support for a strong association between coffee drinking and CVD and no support for the suggestion that caffeine or coffee are causal factors (Gurr, 1997). Many physicians and their patients believe that cardiac arrhythmias (irregular heartbeats) are caused or exacerbated by caffeine but a review by Lynn and Kissinger (1992) concluded that the frequency of arrhythmia was not significantly increased by caffeine and more recently N ewby and colleagues (1996) concluded that caffeine restriction has no role in management of patients with this disorder.

Although there have been small individual studies which appear to show that caffeine may contribute to increases in blood pressure, the majority of studies, including a recent analysis of data from the Multiple Risk Factor Intervention Trial (Stamler et al., 1997), indicate that regular moderate coffee consumption has little influence on blood pressure. It is also clear that decaffeinated, instant, expresso and filtered coffee have no influence on blood cholesterol, but boiled coffee, which is decanted without filtering, and cafetière coffee have been reported to increase it, because of the presence of two lipid-soluble substances, cafestol and kahweol (Urgert et al., 1996). However, the cafetière study has been criticised (Gurr, 1997) on the grounds that the changes observed over the timescale of the study could be explained by seasonal fluctuations in blood cholesterol and because the maximum effect was observed after consumption of large amounts of very strong coffee (more than five cups per day), equivalent to 10-13 cups of normal strength coffee. Overall, the view that coffee drinking, as practised in the UK, is not a risk factor for coronary heart disease (CHD) is confirmed by a report of the Department of Health COMA Cardiovascular Review Group (1994) as well as by the British Heart Foundation (1996), which concluded that moderate coffee consumption (up to six cups per day) would not significantly increase the risk of CHD or stroke in normal healthy people.

Similarly, there is no conclusive evidence that coffee drinking or caffeine is a risk for the development of human cancer. In fact there is epidemiological evidence from several studies suggesting that coffee consumption may be protective against colorectal cancer (Baron et al., 1994; Olsen and Kronberg, 1993; Tavani et al., 1997). The mechanism of this effect is as yet unexplained but could, at least in part, reside in the presence of antioxidant substances in coffee (see section on antioxidants).

Guidelines on diet, nutrition and cancer, issued by the American Cancer Society (1991) found no evidence to recommend against moderate coffee intake. Subsequently, numerous papers have been published showing no causal link between coffee consumption and development of cancer at any site, including a large study of nearly 43,000 people in Norway, where coffee consumption is high (Stensvold and Jacobsen, 1994). A comprehensive review of diet and cancer by the World Cancer Research Fund (1997) also concluded that there was no significant relationship with regular coffee and/or tea drinking and cancer at any site and the report of the Department of Health COMA (1998) Working Group on Diet and Cancer observed only a weak association between high levels of coffee consumption and increased risk of pancreatic cancer.

Coffee and coffee drinking have also been implicated in osteoporosis. It is well documented that there are a variety of aetiological factors contributing to the development of this condition over a long period of time, including oestrogen deficiency, inadequate physical activity, smoking, and nutritional factors (British Nutrition Foundation, 1989). Although there is evidence that regular caffeine intake may lead to an increase in urinary calcium excretion (Massey and Oryszek, 1990), studies on coffee/caffeine consumption and bone density and osteoporosis have yielded conflicting results, probably related to the failure to control for confounding variables.
and discrepancies in caffeine measurement (Lloyd et al., 1997). Overall, it can be concluded that moderate caffeine consumption is not an important factor for osteoporosis provided that people, especially women, consume a healthy diet containing adequate amounts of calcium. This is emphasised by a study of 980 postmenopausal women among whom lifetime caffeinated coffee intake of two cups daily was only associated with decreased bone density in those who did not consume milk on a daily basis (Barrett-Connor et al., 1994). In fact drinking coffee can be a useful way of introducing milk into the diet, especially among young women who, in the U.K., have significantly lower calcium intakes than older women (Gregory et al., 1990).

Numerous studies have examined the association between coffee and/or caffeine consumption and various reproductive factors. Although some negative factors have been reported, there is no conclusive evidence that either coffee or caffeine have significant effects on conception, spontaneous abortion, or fetal and subsequent infant development (Gurr, 1994). The Centre for Pregnancy Nutrition states that “information available at present suggests that five cups of ordinary strength coffee per day (ten cups of tea or cocoa or 12 glasses of cola) is a safe upper limit for pregnant women”. Caffeine can diffuse into breast milk, but one cup of coffee does not present a significant dose of caffeine to the infant (see Gurr, 1994).

Antioxidants in coffee

Coffee, in common with many other plant materials, contains a wide array of substances with antioxidant properties. There is mounting evidence that antioxidants are important in protecting against a range of diseases, including cardiovascular disorders, cancer and other degenerative and age-related conditions such as cataract and Alzheimer's disease (Seis and Krinsky, 1995). Coffee contains a number of the polyphenolic compounds called flavonoids, which possess these properties, and recent research suggests that other substances with antioxidant activity may be generated during the roasting process (Nicoli et al., 1997). Although this is a new area of research, requiring further substantiation, it does suggest that coffee may contribute to antioxidant protection in the body.

What is an acceptable level of caffeine consumption?

Research continues and should be subjected to careful and critical evaluation, but it can be concluded from this brief overview that a moderate intake of caffeine-containing beverages does not pose a risk to health and may even offer some benefits. A small number of people may be especially sensitive to the effects of caffeine on the central nervous system and they need to be aware of their own tolerance level and to drink decaffeinated beverages if necessary. The scientific studies on the physiological and health effects of caffeine have generally used between 250mg and 600mg caffeine as representative of people's average daily intake. A moderate intake is accepted to be about 300 to 400mg per day, i.e. four or five cups of average strength coffee daily, although it is important to take account of caffeine from other sources as well. However, an intake of 500 to 600mg daily, equivalent to six cups of strong coffee, appears to be without adverse effects in most people.

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