THE EFFECT OF DEWAXING OF GREEN COFFEE ON THE COFFEE BREW

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ABSTRACT

The two commercially most important mild treatments for green coffee are the steam treatment and the dewaxing process. In the former treatment the green coffee is just steamed. In the dewaxing process the waxy layer is extracted from the green coffee with an organic solvent, after which this coffee is also steamed to remove solvent residues. Some of the main constituents of the waxy layer are the carboxy-5-hydroxytryptamides (C-5-HT). What happens to these components during the roasting and brewing of the coffee is discussed. During roasting part of the C-5-HT decomposes, but during brewing most of the C-5-HT remains in the spent grounds due to its insolubility.

Literature reports about physiological effects of both types of coffee in human and animal experiments are summarised briefly. For both types of treated coffee additional evidence seems to be needed before hard conclusions can be drawn about their digestibility.

INTRODUCTION

For many years cases of indigestibility of coffee have been an issue of continuing interest. The complaints expressed most frequently are (Stieve, 1965; Sziegoleit *et al.*, 1972*a*,*b*):

A feeling of pressure or fullness in the stomach.
Heartburn.
Internal uneasiness.
A whole series of other complaints, mostly localised in the gastro-intestinal system.

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Starting with the Lendrich process (Lendrich, 1933), according to which the green coffee is subjected to a steam treatment before roasting, several processes have been developed to improve the digestibility of the coffee brew. However, apart from steam treatment only the dewaxing treatment has achieved real commercial importance. This dewaxing consists of the removal of the waxy layer from the green coffee with an organic solvent followed by steaming in order to desolvetise the coffee.

During recent years also some development work has been done on processes designed to reduce the content of chlorogenic acids before roasting.

To date the following groups of components have been indicated to be responsible for the indigestibility of coffee:

Irritating roast products.
Ether-extractables.
Waxy components (such as C-5-HT).
Phenolcarboxylic acids.

Many of these components have not been chemically identified satisfactorily. Of these components, the waxy components—and particularly the carboxy-5-hydroxytryptamides (C-5-HT)—have received much attention during the last ten years.

This paper is divided into four parts:

(i) A mass balance of C-5-HT over the steps of dewaxing, roasting and brewing of the coffee and the consequences thereof for the chemical composition of the brew.
(ii) The chemical consequences of the steaming or desolvetising step.
(iii) The results reported in the literature of the physiological testing of these types of treated coffee.
(iv) Some suggestions for working models for some types of indigestibility relating to treatments of green coffee.

EVALUATION OF C-5-HT

The C-5-HT content of the coffee is used as an analytical parameter for treatments of the waxy layer. Sometimes the C-5-HT themselves have been linked with the indigestibility of the coffee brew, mostly with reference to the pharmacologically active 5-hydroxytryptamine (serotonine). This serotonine is, however, inactive when administered orally. Even oral administration to humans of 60 mg has been reported to be without noticeable effects. In addition, fruits, such as bananas, tomatoes and avocados, contain considerable amounts of serotonine (Udenfriend *et al.*, 1959). It may therefore be concluded that 5-hydroxytryptamine in the coffee brew does not provoke indigestibility.

TABLE 1
C-5-HT CONTENTS OF COFFEE SAMPLES (PPM ON DRY BASIS)

	Untreated	*DCM extracted*
Green coffee	735 ($s = 21$)	266 ($s = 14$)
Roasted coffee	604 ($s = 26$)	189 ($s = 7$)
Spend grounds	699 ($s = 23$)	274 ($s = 13$)

The fact that there is no effect of C-5-HT via serotonine does not mean that C-5-HT has no effect at all. For instance, roast products of C-5-HT could be physiologically active. A method of checking this is to draw a mass balance in order to see how much C-5-HT in any form could get into the brew. Therefore, for the different process steps: dewaxing, roasting and brewing a mass balance was drawn to see what happens to this major component of the waxy layer.

Green coffee, roasted coffee and spent grounds have been analysed with the results shown in Table 1.

TABLE 2
CHANGES IN C-5-HT CONTENTS DURING COFFEE PROCESSING (PPM ON GREEN COFFEE DRY BASIS)

	Untreated	*DCM extracted*
Removed by DCM	—	469
Decomposed on roasting	161	86
Extracted or emulsified on brewing	63	−11[a]

[a] Not significantly different from zero.

If one recalculates the figures shown in Table 1 for dry material loss during roasting and extraction yield at brewing the figures on a green coffee dry material base can be obtained. The changes in the absolute amounts of C-5-HT are, by then, clear (Table 2).

What happened to the amount of C-5-HT which disappeared upon brewing was

TABLE 3
C-5-HT CONTENTS IN COFFEE BREWS

	Untreated	*DCM extracted*
Brewed in the pot (without filter)	2·3 mg/litre	0·5 mg/litre
Filtered (paper filter)	ND	ND

ND = Not detectable.

TABLE 4
PERCENTAGE DISTRIBUTION OF C-5-HT

	Untreated (%)	*DCM extracted* (%)
Removed by DCM		64
Decomposed on roasting	22	12
Spent grounds	70	26
In brew/retained by paper filter	6–9	0–1
Total	98–101	102–103

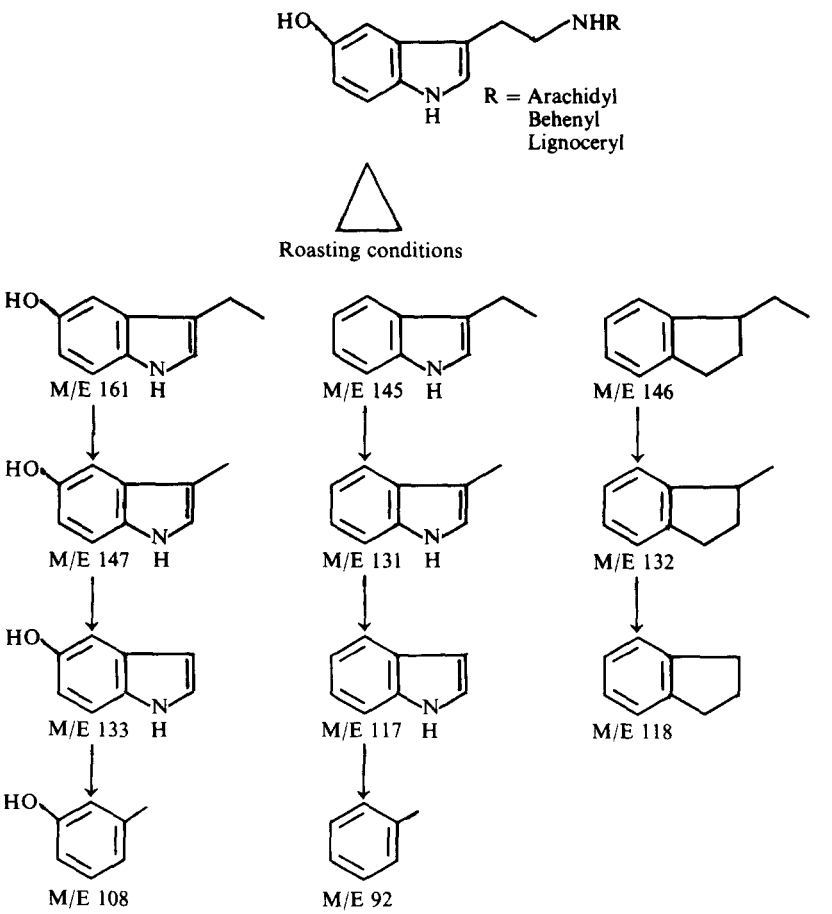

Fig. 1. Thermal decomposition of serotonin amides (Viani *et al.*, 1975).

checked in an experiment where the C-5-HT contents of two brews—one made with, and one without, a paper filter—were measured (Table 3).

These figures are summarised in the percentage distribution shown in Table 4. From these figures two things are clear. First, that a small part of the C-5-HT may pass into the brew. However, if a paper filter is used no C-5-HT is detectable in the brew. This could indicate that the C-5-HT which passes into the brew does so via the emulsified oil phase.

In addition to these intact C-5-HT, the possibility of roast products of the C-5-HT passing into the brew has to be considered. Secondly, the amount of C-5-HT decomposed by roasting is considerably reduced by removal of the waxy layer.

With regard to the identity of the products formed at roasting, Viani *et al* (1975) (Nestlé) has reported some results concerning the roast products of C-5-HT (Fig. 1). Some of these products, especially the phenolic ones, are water soluble and thus may be expected to pass into the brew. Removal of the waxy layer before roasting will thus result in a reduction in the content of phenolic roast products of C-5-HT in the brew.

CHEMICAL EFFECTS OF THE STEAM TREATMENT

The chemical effects of the steam treatment (either in the Lendrich process or as the desolvetising step in the dewaxing process) have been reported in the literature in a number of cases. Mentioned in this respect have been the ether-extractables (Albanese, 1964; Mülhens, 1972), sulphur compounds (Albanese, 1964; Kaden, 1962) and polysaccharides (Albanese, 1964; Meyer, 1978). Conflicting results have been reported about what happens to the chlorogenic acids during steaming (Lendrick, 1933; Albanese, 1964; Kaden, 1962; Kröplein, 1963; Werner *et al.*, 1965; Windeman, 1974). Possibly the most evident effects are those from the work of Windeman (1974), Gal *et al.* (1976) and Meyer (1978).

The results of Windeman (1974) are especially interesting. He reported the presence of 3-methoxy-4-hydroxystyrene in the steam condensate. This phenolic component is formed by decomposition of feroylquinic acid which belongs to the group of chlorogenic acids. Whereas Windeman found in a closed autoclave only a low degree of formation of 3-methoxy-4-hydroxystyrene, this formation might be increased in a system with constant steam or condensate discharge and more optimal conditions for temperature, moisture content of the coffee and time (as is approached by desolvetising conditions).

Summarising the discussed chemical effects of dewaxing and steaming one may expect that both treatments contribute to a reduced content of phenolic components in the brew. Dewaxing does so via a reduction of the phenolic roast products of C-5-HT and steaming via the removal of the 3-methoxy-4-hydroxystyrene.

PHYSIOLOGICAL TESTS ON TREATED COFFEE

In order to study the digestibility of treated coffees several types of test have been reported, as follows:

Using pigeons or dogs to measure the emetic activity of the brew (Behrens & Malorny, 1940; Kudsi, 1964; Malorny *et al.*, 1967).
With rats having stress ulcers induced by immobilisation in narrow cages—the effect of coffee on the healing of these ulcers has been studied (Frommolt *et al.*, 1972).
Bile secretion has been measured with rats and intestinal motility by ink transportation upon mice (Czok & Lang, 1963).
In humans the experiments are, apart from X-ray studies, usually limited to acid secretion and pH measurements in the stomach (Stieve, 1965; Rösner *et al.*, 1971; Finterlman *et al.*, 1978) and scoring of the different types of complaint (Sziegoleit *et al.*, 1972*a*,*b*).

The following test results for treated coffee have been reported.

Dewaxed coffee was found to give less retardation in the healing of stress ulcers in rats than regular coffee (Frommolt *et al.*, 1972). In humans dewaxed coffee was found to give a lower secretion of gastric acid than regular coffee (Rösner *et al.*, 1971).

The steam treatment was found to reduce the stimulation of bile production and of intestinal motility (Czok & Lang, 1963). The steam treatment was also shown to reduce the emetic activity of the brew (Behrens & Malorny, 1940; Kudsi, 1964; Malorny *et al.*, 1967). In these studies the brew was also fractionated in order to search the components responsible for the emetic activity. This activity was localised in the group of components that are extractable with ether from an acidified brew. This method of isolation suggests that the group consists of weakly acidic components such as, for example, phenols and pyrrols. Indeed, phenolic components have been identified in this fraction (Högl & Mosimann, 1958) and these phenolics were also found to be emetic (Malorny *et al.*, 1967). In tests on the effects of steamed coffee on gastro-enterological patients it was found that steamed coffee provoked less complaints than regular coffee in liver and gall bladder patients (Sziegoleit *et al.*, 1972*a*,*b*). In this respect it is interesting to know that feroylquinic acid has been indicated as one of the cholinergic factors of the brew (Czok, 1977). It was recently reported that a coffee subjected to a steam–hot air treatment showed reduced changes of the gastric juice pH (Finterlman *et al.*, 1978).

SUGGESTIONS FOR WORKING MODELS

Summarising the discussed chemical differences due to the treatments and the physiological effects of the treated coffees, it can be stated that the physiologically

active components of the brew, other than caffeine, are still not fully chemically identified. Nevertheless, it could be interesting to consider some working models on the basis of the known facts. These models are, however, still very speculative.

Both dewaxing and steaming were found to contribute to a reduced phenolics content in the coffee brew, dewaxing via phenolic roast products of C-5-HT and steaming via the removal of 3-methoxy-4-hydroxystyrene. Such a reduction of phenolics—and thus of ether-extractables—could positively contribute to the digestibility of the coffee via a reduction of the emetic activity of the brew. But chemical elucidation of the ether-extractables and identification of the main emetic factor is still needed.

Another interesting combination of results is:

(a) The decomposition of feroylquinic acid during steaming or desolvetising and the removal of the decomposition product 3-methoxy-4-hydroxystyrene (Windeman, 1974; Gal *et al.*, 1976).
(b) The finding that feroylquinic acid is one of the cholinergic factors of the brew (Czok, 1977).
(c) The reduced frequency of complaints after consumption of steamed coffee by a group of liver and gall bladder patients (Sziegoliet *et al.*, 1972*a*,*b*).

As feroylquinic acid has cholinergic activity it is logical that decomposition of this compound by steaming reduces the frequency of complaints from liver and gall bladder patients. At least for this type of indigestibility this could be a plausible explanation.

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