UNIVERSITI PUTRA MALAYSIA

EFFECT OF ROASTING ON THE DEVELOPMENT OF FLAVOUR IN MALAYSIAN COCOA BEANS (*Theobroma cacao* L.)

FARIDAH BT AB AZIZ

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EFFECT OF ROASTING ON THE DEVELOPMENT OF FLAVOUR IN MALAYSIAN COCOA BEANS (*Theobroma cacao* L.)

by

FARIDAH BT AB AZIZ

A thesis submitted in partial fulfilment of the requirements for the degree of Master of Science in the Faculty of Food Science and Technology, Universiti Pertanian Malaysia

March, 1986

It is hereby certified that we have read this thesis entitled 'Effect of Roasting on the Development of Flavour in Malaysia Cocoa Beans' by Faridah bt Abdul Aziz, and in our opinion it is satisfactory in terms of scope, quality and presentation of partial fulfilment of the requirements for the degree of Master of Science

ALANG P. ZAINUDDIN, Ph.D.
Assoc. Professor/Dean of Graduate Studies
Universiti Pertanian Malaysia
(Chairman Board of Examiners)

P.G. KEENEY, Ph.D.
Professor
College of Agriculture
Peninsular State University
U.S.A.
(External Examiner)

MARY ANN AUGUSTIN, Ph.D.
Lecturer
Department of Food Science
Faculty of Food Science and Technology
Universiti Pertanian Malaysia
(Internal Examiner)

ASIAH MOHD. ZAIN, M.Sc.
Assoc. Professor/Head
Department of Food Technology
Faculty of Food Science and Technology
Universiti Pertanian Malaysia
(Supervisor)

This thesis was submitted to the Senate of Universiti Pertanian Malaysia and was accepted as partial fulfilment of the requirement for the degree of Master of Science.

ALANG P. ZAINUDDIN, Ph.D.
Associate Professor/
Dean of Graduate Studies.

Date: 09 OCT 1986

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EFFECT OF ROASTING ON THE DEVELOPMENT OF FLAVOUR

IN MALAYSIAN COCOA BEANS (*Theobroma cacao* L.)

by

Faridah Bt Ab Aziz

March, 1986

Supervisor : Associate Professor Asiah Mohd. Zain

Co-Supervisor: Dr. Mamot Said

Faculty : Food Science and Technology

Malaysian cocoa beans have been characterised by chocolate manufacturers as lacking strong cocoa flavour. To have an insight into the flavour problem, research was carried out to see how roasting would affect the chemical and flavour components as well as the acceptability of dark chocolate prepared from the beans. The roasting condition used was 150°C for 15, 30 and 45 minutes.

It was found that a temperature difference existed between the oven temperature and the temperature of the bean during roasting. The difference was 55°C at the tenth minute and down to 20°C at the end of the 45 minutes roasting, respectively.

The moisture content of the beans decreased with roasting time while the pH remained unchanged. Theobromine content decreased by 11.61 per cent after 45 minutes roasting. Total polyphenols decreased slightly by 6.21 per cent while total reducing sugar content decreased by 58.54 per cent by the end of 45 minutes roasting, respectively. The total amino acid content also decreased by 61.95 per cent after 45 minutes roasting.

No definite pattern of isopentanal development was obtained using the headspace sampling method. A more definite pattern, however, was obtained for the development of pyrazines. From the four pyrazines detected, tetramethylpyrazine was the major pyrazine that was detected throughout the roasting experiment.

Data from the Ranking Preference Test indicated that dark chocolate prepared from the beans roasted at 150^{o}C for 45 minutes was most preferred. Triangle Test Difference Analysis showed that there was a difference between the dark chocolate prepared from this Malaysian beans and dark chocolate prepared from Ghana beans roasted at 150^{o}C for 30 minutes. The latter was more preferred over the former. However, Ranking Preference Test for the two samples indicated that the preference was not significant.

Abstrak tesis yang dikemukakan kepada Senate Universiti Pertanian Malaysia sebagai memenuhi sebahagian daripada keperluan untuk Ijazah Master Sains.

'EFFECT OF ROASTING ON THE DEVELOPMENT OF FLAVOUR IN MALAYSIAN COCOA BEANS (*Theobroma cacao* L.)'

Oleh

Faridah Bt Ab Aziz

Mac, 1986

Penyelia : Professor Madya Asiah Mohd. Zain

Penyelia Bersama: Dr. Mamot Said

Fakulti : Sains dan Teknologi Makanan

Pembuat-pembuat cokelat menganggap biji-biji koko dari Malaysia sebagai mempunyai perisa koko yang lemah. Sehubungan dengan ini, satu kajian telah dijalankan untuk mengetahui bagaimana proses pemanggangan mempengaruhi komponen kimia dan perisa serta penerimaan cokelat yang disediakan dari biji-biji koko. Biji-biji koko yang digunakan untuk kajian dipanggang pada suhu 150°C selama 15, 30 dan 45 minit.

Terdapat perbezaan suhu di antara suhu ketuhar dengan suhu biji-biji koko sepanjang pemanggangan. Perbezaan suhu adalah

setinggi 55^{o}C pada masa 10 minit dan berkurangan kepada 20^{o}C selepas 45 minit pemanggangan.

Kandungan kelembapan berkurangan di sepanjang masa pemanggangan, manakala nilai pH tidak berubah. Kandungan teobromina berkurangan sebanyak 11.61 peratus selepas 45 minit pemanggangan. Jumlah polifenol berkurangan sebanyak

penurun berkurangan sebanyak 58.54 peratus selepas 45 minit pemanggangan. Kandungan asid amino jumlah juga berkurangan sebanyak 61.95 peratus selepas 45 minit pemanggangan.

'Isopentanal' didapati tidak mempunyai pembentukan yang jelas dalam kajian ini berbanding dengan pembentukan pirazina. Dari empat jenis pirazina yang dapat dikesan, tetrametilpirazina adalah jenis pirazina yang banyak terbentuk di sepanjang kajian pemanggangan.

Data dari ujian 'Ranking Preference' menunjukkan cokelat hitam yang disedia dari biji-biji koko yang telah dipanggang pada suhu 150^{o}C selama 45 minit adalah yang paling digemari. Data dari 'Triangle Test' menunjukkan ada perbezaan di antara cokelat dari biji koko dari Malaysia dengan cokelat yang disediakan dari biji-biji koko dari Ghana yang telah dipanggang pada 150^{o}C, selama 30 minit. Cokelat yang disediakan dari biji-biji koko Ghana adalah lebih digemari. Data dari ujian 'Ranking Preference' menunjukkan kegemaran ini tidak bererti.

CHAPTER 1

INTRODUCTION

The rapid expansion of cocoa cultivation in Malaysia began as a result of the rise in the price of cocoa in 1974 - 1978. The crop has now become the nation's third major export commodity (after rubber and oil palm). The area under cultivation has increased from about 3,000 hectares in 1965 to about 180,231 hectares in 1982; the total acreage is expected to reach 250,000 hectares by the year 2,000.

Production of the dried beans has increased from 5,000 metric tonnes in 1971 to 66,000 metric tonnes in 1982, with a projected increase to 120,000 metric tonnes by the year 1990. In 1982, 57,485 metric tonnes worth MR$198.1 million dried cocoa beans was exported compared to 4,000 metric tonnes dried cocoa beans worth MR$6.5 million in 1972. In addition, the export of cocoa products, including chocolate, has also increased from 563 metric tonnes worth MR$2.3 million in 1972 to 4,586 metric tonnes worth MR$40.4 million in 1981 (Kementerian Pertanian, 1984).

Malaysian cocoa beans have been reported to be of lower quality compared to Ghana cocoa beans. Some of the lower quality attributes that have been identified to be associated with Malaysian cocoa beans are small and non-uniform bean size, high shell content and high bean acidity. The high bean acidity, due to poor fermentation practices, has been reported to contribute to the poor flavour of the beans (Shepherd and Chick, 1983).

Cocoa beans are largely used in the manufacture of cocoa and chocolate products. A good quality cocoa is one with the inherent flavour of the type of beans concerned. Reports have indicated that the type of cocoas from various origins differ in some of their quality attributes but they all produce a good chocolate flavour. The major stages that contribute to good chocolate flavour are during the harvesting of the ripe pods, the fermentation of the beans, as well as the roasting process. If any of these stages are mishandled, the proper mixture of the components in the beans may not be present to develop a good chocolate flavour.

Although Malaysian cocoa beans are now accepted in the world market, the beans are subjected to price discount on the London terminal market, as compared to Ghana beans because of its lower quality. Concerted efforts are being taken by the private sector and relevant Government agencies to overcome the quality problems, through the use of better planting materials, better fermentation and drying techniques and export grading of the cocoa beans.

Past research has mainly concentrated on the primary processing stage and directed towards solving the acidity in its relation to flavour through manipulation of the fermentation and drying techniques (Mamot Said and Shahrir Shamsudin, 1983). Although the bean acidity problem has been reduced, Malaysian cocoa beans still produce weak flavour.

Research has shown that cocoa beans need a heat-curing process, as in roasting, to produce a full characteristic flavour (Knapp, 1937; van der Waal, *et al.*, 1971). Changes taking place within the beans during this process, therefore, represent an important area for study. Information on the compounds formed or removed during this process may be helpful in predicting the actual reasons for the weak flavour of Malaysian fermented cocoa beans.

This study was carried out to investigate the following:

(i) The effect of roasting on some of the chemical components of the beans.

(ii) The effect of roasting on carbonyl formation in the beans.

(iii) The effect of roasting on pyrazine formation in the beans.

(iv) The effect of roasting on the acceptability of chocolate prepared from the beans.

CHAPTER 2

LITERATURE REVIEW

Flavour in chocolate is influenced by many variables including the types of cocoa beans used, postharvest treatments involved in preparing the beans for export, as well as processing of the beans in the chocolate factory where the final flavour development is accomplished (Knapp, 1937; van der Waal, *et al.*, 1971; Keeney, 1972).

ROASTING OF COCOA BEANS

The purpose of roasting is to develop flavour and aroma and to render the cotyledons (nibs) sufficiently plastic for easy grinding. The seed coat is also loosened by roasting and thus transformed into a readily removable shell (Chatt, 1953; Kleinert, 1966). No rigid rules can be laid down for time and temperature of roasting as these factors vary with size and type of beans, their moisture content, kind of equipment used and according to whether the ultimate product is plain chocolate or milk chocolate. The heat is so regulated that it penetrates to the centre of the beans without causing outer tissues to acquire a burnt flavour. It acts from the outside of the nib towards the inside and gives rise to chemical and physical changes which can be followed analytically (Kleinert, 1966).

The composition of the aroma fraction is determined to a large degree by the roasting process. The conditions normally used during the roasting of cocoa beans are at temperatures 120°C to 190°C (Bailey, et al., 1962; Rohan and Stewart, 1966a; Rohan and Stewart, 1967c; Weissberger, et al., 1971; Darsley and Quesnel, 1972; Keeney, 1972; Zak and Keeney, 1976). Heat transfer and chemically induced chemical changes at these temperatures will of course be influenced by such factors as hold time, air movement and the design of the roaster. The period of roasting may vary from 15 minutes to two hours. Flavour is somewhat crude and underdeveloped when the beans are insufficiently roasted. However, when roasting is too vigorous, excessive darkening and a decrease in available protein will résult (Jensen, 1931). Under laboratory conditions Keeney (1972) reported that roasting periods longer than 30 to 40 minutes were excessive, since unpleasant scorched or burnt characteristics were becoming dominant.

Beans that are to be roasted should be reasonably uniform in size (Roelofsen, 1958; Bailey, et al., 1962) and the colour of the colour of the cotyledon (nib) should range from purple and brown to fully brown, with acid medium of pH 4.5 to 5.5. According to Rohan and Stewart (1967c), the beans should have a low moisture content of six per cent, while Liau (1976) recommended a moisture content of not more than eight per cent.

Roasting by means of hot air offers the advantage of greater uniformity and rapidity (Chatt, 1953). Depending on the type of roasting conditions applied, roasted beans will result in a decrease of moisture content between one to five per cent. The eventual loss of moisture and volatile organic acids (mainly acetic) accounts for a shrinkage of about five to six per cent. The shell content of roasted beans varies from eight per cent in very thin skinned beans to 14 per cent in heavy shelled types (Cook, 1972).

Samples of comm

roasting a few handfuls in a sample roaster. The flavour developed in this way is similar to that produced by roasting on a commercial scale (Roelofsen, 1958).

FLAVOUR PRECURSORS

Precursors of chocolate flavour are many but theobromine, polyphenols (Wadsworth, 1955; Forsyth et al., 1958), sugars and amino acids are acknowledged to be the major precursors (Rohan, 1963; 1964). However, these flavour precursors are not present in the beans at the time of harvest but have to be produced by the process of fermentation from the products furnished by the break-down of the proteins and sugars (Foster, 1978). The key to the development of the flavour precursors is the change in the cell membranes which occurs after the beans have died during fermentation. During this time, enzymes are released, sugars and proteins are hydrolysed and the tannins are oxidised. This is an important stage because the reactions of these various components must be complete, otherwise the beans will have a bitter, undesirable flavour. The flavour is then manifested during roasting (Rohan, 1972; Liau, 1977; Reymond, 1977) whereby, firstly, some compounds are driven off, and secondly, the amino acids, sugar breakdown products and polyphenols are all starting to form new compounds, some of which will be flavour compounds and some colour compounds.

The whole process culminated in the subtle and well balanced cocoa flavour to which hundreds of constituents contribute.

Theobromine

Cocoa beans contain two principal purine bases, namely theobromine (about 1.5 per cent in the dry cotyledon) and caffeine (a minor constituent at 0.15 per cent) (Pickenhagen and Dietrich, 1975).

Theobromine (3, 7-dimethylxanthine) is a white crystalline powder which sublimes without melting at 290^{o}C. It is a weak base slightly soluble in cold water and alcohol, and more readily dissolved on heating. It is soluble in chloroform and tetrachloroethane. Its loss during fermentation as exudate is partly responsible for the reduction in bitterness of the cotyledons. The quantity remaining is sufficient to impart a slightly bitter but not unpleasing taste to cocoa products (Chatt, 1953). According to Brown (1957), the bitterness due to the purine bases (theobromine and caffeine) develops at a relatively later stage in the tasting of chocolate. The effect obtained depends on the ratio of caffeine to theobromine in the total purines content and not due to preparatory processes. Pickenhagen and Dietrich (1975), however, reported that bitterness in cocoa is due to interaction of cyclic dipeptides with theobromine present; these cyclic dipeptides are formed in trace amounts during cocoa roasting.

Wadsworth (1922) reported that 0.9 to 1.7 per cent theobromine is present in cocoa samples. Using high pressure liquid chromatographic procedures, Kreiser and Martin (1978), too, found a range of theobromine contents from 0.8 to 1.7 per cent for cocoa beans from various locations.

Polyphenols

Colour and flavour of cocoa have long been associated with the phenolic constituents of the beans (Wadsworth, 1955; Brown, 1957; Kleinert, 1965; Maravalhas, 1972a). Three major groups of phenols present are catechins, anthocyanins and leucocyanidins with catechin type compounds and leucocyanidins being the major components of the flavour compounds (Forsyth, 1955). The major catechin amounting to more than 90 per cent of the total catechins was found to be (-) epicatechin (Forsyth, 1952). This was supported by Roelofsen (1958) who reported that the amount of diffusion of polyphenols out of the kernel during fermentation was estimated at one-third of its original content with epicatechin being the most mobile fraction.

According to Schubiger *et al.*, (1957), polyphenol (tannins) in cocoa beans react with the proteins to form insoluble polyphenol-protein complexes. This reaction has a favourable effect on the flavour of cocoa (Forsyth *et al.*, 1958) whereby the astringent taste is reduced. The formation of these polyphenol-protein complexes also prevents the unpleasant taste which is produced when the unchanged proteins are roasted. The astringency that is present is desirable in a plain chocolate and is part of the overall picture of a good bitter chocolate. However, it must not be there in excess, otherwise the acceptability is reduced (Purr *et al.*, 1963).