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Short Communication

X-ray diffraction study of *kanwa* used as active ingredient in *achu soup* in Cameroon

Georges-Ivo E. Ekosse

Directorate of Research Development, Walter Sisulu University, P/Bag XI Mthatha 5117; Eastern Cape, South Africa. E-mail: gekosse@wsu.ac.za.

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In this study, x-ray powder diffractometry (XRPD) technique was used to identify the mineral constituents of *kanwa*; an earthy material widely used as active ingredient in *achu soup* and other vegetable soups in Cameroon and several other West African countries. Results depicted trona ($Na_3H(CO_3)_2.2H_2O$) to be the main mineral constituent. It reacts with palmitic and oleic acids in palm oil and both sodium palmitate and sodium oleate are produced which are responsible for the unique, characteristic and cherished taste of *achu soup*.

Key words: X-ray powder diffractometry, *kanwa*, *achu soup*, Cameroon.

INTRODUCTION

Kanwa is a local earthy material used widely in West Africa and particularly in Cameroon, Ghana and Nigeria, as a cooking ingredient in vegetable soups. In the North-west Province of Cameroon, it is used to prepare the most cherished *achu soup*; the mainstay soup made from water, palm oil and dried beef. Palm oil consists mainly of 40 - 50% oleic acid and 35 - 45% palmitic acid. Other compounds in palm oil in small to minute quantities are linoleic acid, stearic acid, myristic acid, arachidic acid, lauric acid and linolenic acid. It also contains > 500 g Kg^{-1} of carotene; which is its main colouring agent. The *kanwa* is dropped into the boiling water and palm oil. As it boils, air bubbles are released. The soup is eaten with pounded cocoyam. Although *kanwa* is widely used in Cameroon and several other West African countries, no documented study has been reported of its mineralogy. In this work, X-ray diffraction technique was used to identify the mineral constituents of *kanwa* and an attempt was also made to elucidate on essential chemical reactions of it and palm oil.

MATERIALS AND METHODS

Five samples of *kanwa* purchased from vendors in five different towns (Bamenda, Limbe, Kumba, Mutengene and Tiko) in Cameroon were obtained for the identification of minerals contained in them. The samples were gently crushed into powder and the minerals identified with the aid of a Philips PW 3710 XRPD X-ray diffractometer system, operated at 40 kV and 45 mA, having a Cu-K_α radiation and a graphite monochromator. A PW 1877 Automated Powder Diffraction, X'PERT Data Collector software package was employed to capture raw data and a Philips X'PERT Graphics and Identify software package was used for qualitative identification and semi quantitative analyses of the minerals from both the data and patterns obtained by scanning at a speed of 1°2□ / min. Samples were scanned from 2°2□ to 70°2□. The interpreted results were compared with data and patterns available in the Mineral Powder Diffraction File, data book (International Centre for Diffraction Data, 2001).

RESULTS AND DISCUSSION

The main mineral constituent identified is trona, $Na_3H(CO_3)_2.2H_2O$ (Figure 1), which is basically sodium bicarbonate with water of crystallisation. Traces of halite (NaCl) and quartz (SiO_2) were also found to be present. Trona is sodium bicarbonate formed as a non marine evaporate.

Palmitic and oleic acids are carboxylic acids. More specifically, palmitic acid ($(CH_3(CH_2)_{14}COOH$ or simply $C_{15}H_{31}COOH$) is a C_{16} saturated carboxylic and oleic acid ($(CH_3(CH_2)_7CH=CH(CH_2)_7COOH$ or simply $C_{17}H_{33}COOH$) is a C_{18} mono-unsaturated carboxylic acid denoted as: (C18:1), with one double bond in the carboxylic acid. These acids are generally represented as RCOOH (carboxylic acids) and they dissociate to give carboxylate ion and a proton as shown in Equation 1:

$$RCOOH \rightleftharpoons RCOO^- + H^+ \quad (1)$$

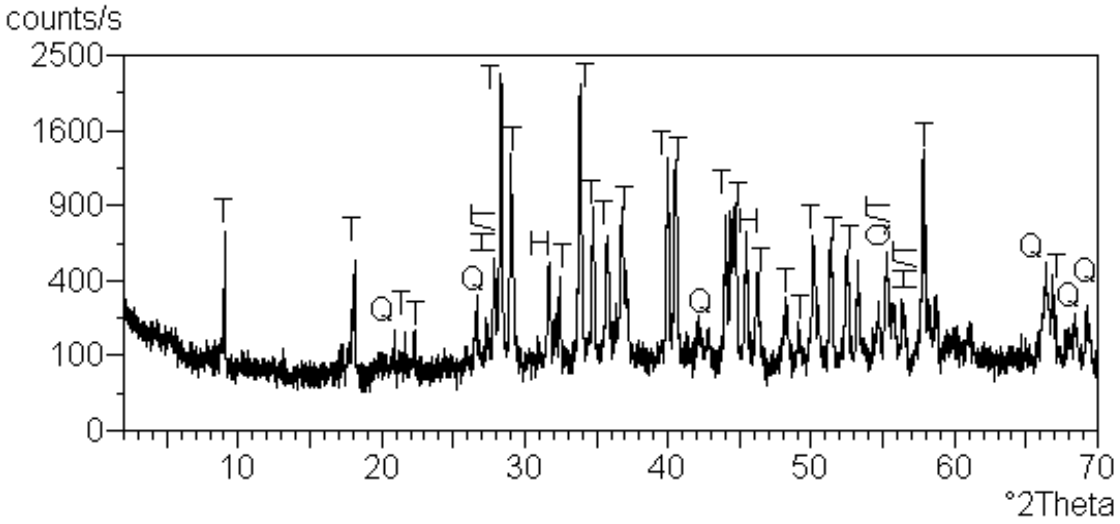

Figure 1. X-ray diffractogram of a representative sample of *kanwa* (H = halite, T = trona, Q = quartz).

In this vein, $NaHCO_3$ (sodium bicarbonate) which constitutes trona reacts with carboxylic acids contained in the palm oil as follows:

$$RCOOH + NaHCO_3 \rightarrow RCOONa + H_2O + CO_2\uparrow \quad (2)$$

Where RCOONa is sodium carboxylate. Considering palmitic acid, its reaction with $NaHCO_3$ is shown in Equation 3:

$$CH_3(CH_2)_{14}COOH + NaHCO_3 \rightarrow CH_3(CH_2)_{14}COO^- Na^+ + HCO_3^- \quad (3)$$

Palmitic acid Sodium palmitate

This reaction proceeds replacing H^+ in the HCO_3^- and giving the overall reaction (Equation 4):

$$CH_3(CH_2)_{14}COOH + NaHCO_3 \rightarrow CH_3(CH_2)_{14}COONa + H_2CO_3 \quad (4)$$

carbonic acid

But H_2CO_3 is not stable and as such it decomposes as indicated in Equation 5:

$$H_2CO_3 \rightarrow H_2O + CO_2\uparrow \quad (5)$$

Similar to the palmitic acid reaction, the overall reaction between oleic acid and $NaHCO_3$ is as indicated in Equation 6:

$$CH_3(CH_2)_7CH=CH(CH_2)_7COOH + NaHCO_3 \rightarrow CH_3(CH_2)_7CH=CH(CH_2)_7COONa + H_2CO_3 \quad (6)$$

Equation 6 could be simplified as follows:

$$C_{17}H_{33}COOH + NaHCO_3 \rightarrow C_{17}H_{33}COONa + H_2CO_3 \quad (7)$$

Then the H_2CO_3 decomposes to H_2O and CO_2 is given off.

Conclusion

Trona which is basically sodium bicarbonate with water of crystallisation has been identified to be the main constituent of *kanwa*. It reacts with the weak carboxylic acids in palm oil producing $CH_3(CH_2)_{14}COONa$ and $CH_3(CH_2)_7CH=CH(CH_2)_7COONa$. Being weak acids (RCOOH) reacting with a weak base ($NaHCO_3$), the reaction may be slow and is therefore quickened by the hot boiling water as CO_2 is given off as air bubbles.

Both the palmitate and oleate of Na give the unique, characteristic and cherished taste of *achu soup*. For West Africans and particularly Cameroonians in diaspora who would like to continue to enjoy their traditional dishes and particularly *achu soup* but cannot readily obtain *kanwa*, pharmaceutical grade $NaHCO_3$ can possibly be used.

REFERENCES

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