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Effect of X-Ray Exposure (mAS) on Sugar Concentration and Acid Values f Honey

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Abstract

Samples of honey obtained from GM pure honey a product of healing well enterprise Tungo Minna Niger State (labeled as sample A) and locally produced honey obtained from Obarike Ito Benue State (labeled sample B) both in Nigeria were irradiated at an X-ray tube potentials between 45 kVp and 65 kVp which are within the diagnostic potentials and analyzed using AR200 Digital Refractometer and pH meter. The Refractive index (nD), Sugar Concentration (SC), Acid values (pH) and Moisture concentration were evaluated. It was observed that X-ray irradiation of honey actually causes changes in its measured values with the sugar concentration (% Brix) ranging from 74.4 ± 0.2 to 73.2 ± 0.3 at tube potentials of 45 to 65 kVp for sample A. The acid value also varies from 4.74 ± 00.2 to 4.58 ± 0.03 with moisture content ranging from 24.2% to 20.6%. Similarly for sample B, the sugar concentration (SC) varies from 78.3 ± 0.2 % Brix to 83.2 ± 0.2% Brix, it measured pH lies between 4.97 ± 0.02 to 5.10 ± 0.04, with moisture content of 19.4% to 21.0% at an irradiated tube potential of 45 to 65 kVp. Those measured values do not have a steady defined pattern, but had values that were significant in some cases when compared with those of the control. Hence there is need for caution in referring patients who are undergoing honey therapy for X-ray diagnosis.

Keywords: Sugar Concentration, Moisture Content, X-ray Irradiation, Honey.

1.0 Introduction

Honey is a sweet food made by bees using nectar from flowers. Honey bees transform nectar into honey by a process of regurgitation and evaporation [1]. Honey has been used since ancient times in many cultures as an effective remedy [2- 4] cures bacterial infections [5-8] through its antibacterial and Fungal Species [9,10]. Honey widely used as tropical antibacterial agent for treatment of wounds, burns and skin ulcer [11]. It is a traditional remedy for dyspepsia, peptic ulcer [10] and gastritis caused by enteropathogenic bacteria.

The antibacterial activity of honey could be attributed to several factors [9, 11, 12]

The first factor is the osmotic effect of honey. Honey is a saturated or super-saturated solution of a mixture of fructose and glucose sugar (84%), therefore, no fermentation occurs in honey. Inhibition by the osmotic (water-withdrawing) effect of dilute solutions of honey obviously depends on the species of bacterial [9].

The second factor for the antibacterial activity of honey is its acidity. The pH between 3.2 and 4.5 is low enough to be inhibitory to many pathogens. However, if honey is diluted, especially by blood fluids, the pH will not be low enough to effectively inhibit bacteria [9,13]. The third factor is the presence of hydrogen peroxide in honey. Hydrogen peroxide is enzymatically in honey by glucose oxidize enzymes secreted by bees into the nectar. Although, hydrogen peroxide has been used as an antiseptic [14], it is not now as popular because it causes inflammation and damage to tissues [15,16]. In honey, the enzymes found is activated by dilution and the peroxide produced is too mild to cause tissue injury, and yet has antibacterial activity [17,18].

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The fourth factor is the presence of antibacterial phyto-chemical components [19],[20]. The fifth factor is the presence of defensin-1, which was recently found to contribute in the antibacterial activity of honey [11]. The sixth factor is the in vivo antibacterial activity of honey in the induction of increased lymphocytes and phagocytic activity.

The discovery of X-rays by physicist gave rise to a rapid development in medical diagnosis and therapy. X-ray are produced when highly energetic electrons interact with matter and convert their kinetic energy into electromagnetic radiation. A device that accomplishes such a task consists of an electron source, an evacuated path for electron acceleration, a target electrode, and an external energy source to accelerate the electron [21].

There are a number of different ways in which a photon of X-ray can interact with matter. One of the major interaction mechanism is the Compton scattering, the equations that are used to relate the energy and angle of emerging photon and electron, as well as the equations that give the cross section for the scattering, are usually derived assuming that the electron is free and at rest.

A photon has energy E and momentum P, related by

$E=h\nu = PC$ (1)

This is a special case of a more general relationship from special relativity:

$E^2= (PC)^2 + (M_0C^2)^2$ (2)

In this equation M_0 is the "rest mass" of the particle and M_0C^2 is the "rest energy". For a photon, which can never be at rest, $M_0=0$. Thus the average energy transferred to an electron in a Compton interaction is defined to be

$$\delta_{tr} = \int_0^{\pi} \frac{d\delta_c}{d\Omega}\frac{T(\theta)}{h\nu_0} 2\pi sin\theta d\theta = f_c\delta_c \quad (3)$$

Where $\delta_{tr}\, is$ the energy transferred cross-section, δ_c is the total cross-section, T(θ) is the energy of the recoil electron, ν_0 is the initial frequency, f_c is the total force and $f_c\delta_c$ is the result of the total cross-section δ_c for Compton scattering by a single electron and the energy transfer is δ_{tr} .

2.0 Materials and Method

Honey procured from GM pure honey a product of healing Well enterprise Tungo Minna, Niger State (labeled sample A) and locally produce honey obtained from Obarike Ito Obi local Government, Benue State (labeled sample B) were filtered using a piece of cotton materials, which has been previously washed in distilled water. The filtration was necessary to eliminate any solid particle present. 15cl of the filtered honey was measured with a pipette into 12 previously sterilized 20cl plastic containers having 5cm internal diameter. These containers were covered and left on the work bench in readiness for irradiation; though the covers were remove before the samples were irradiated.

A high frequency X-ray machine (R501 GEC) with an overhead tube belonging to the Radiology Department of the Mkar Christian Hospital, Gboko was used to irradiate the samples. To actually study the effect of changing the tube potential on the honey, a constant current time factor of 100 mAS was maintained during the process of irradiation. Tube potentials of 45,50,55,60 and 65 kVp which represents the typical range of tube voltages were used in irradiation, with each potential used in irradiating a set of 10 samples. A separate set of the two samples was left un-irradiated and therefore used as control. The method of irradiation used is similar to those used in [22] with the sample placed on the X-ray couch, 1 meter away from the X-ray tube port (focus) to allow the beam diameter to properly cover the container diameter.

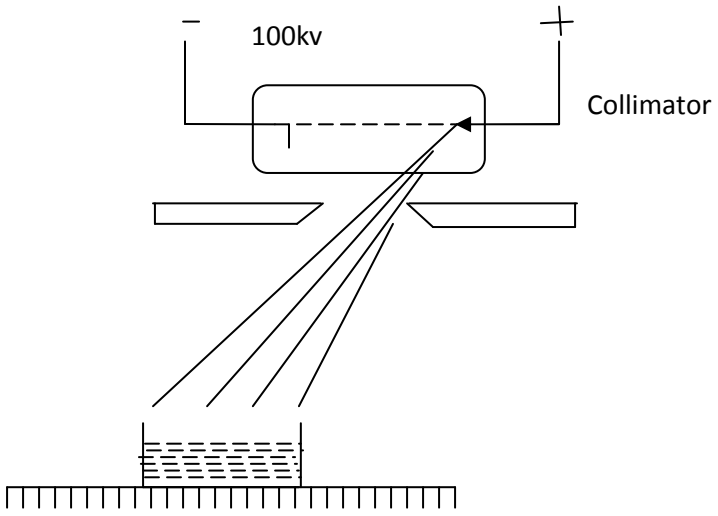

Fig. 1: Experimental set-up.

The acid values of each set of irradiated sample and control was determined by measuring with a pH meter, WTW model pH-192, whose calibration was cross checked with a standard buffer solution. The sugar concentration (SC) and refractive index (nD) of the samples were measured using an AR200 Refractometer which is a high precision optical instrument. The AR200 is capable of measuring % solid (Brix), % solid-TC (Brix-Temperature compensated), it is preprogrammed at the factory with channel 1 to read % sucrose or "Brix" scale per International Commission for uniform methods of sugar Analysis (ICUMA).

3. **Results and discussion**

Results of the sugar concentration (SC), acid values (pH), refractive index (nD) and moisture content of the respective honey samples studied are presented in Table 1 and 2 and Fig. 2 and 3 respectively.

Table 1. Results of experimental procedure on sample A

Tube potential (kVp)	Refractive index (nD)	Moisture content (%H_2O)	Sugar concentration (%Brix) at 20^0	Acid values (pH)
(Control) 0	1.489	18.6	78.2±0.4	4.90±0.04
45	1.488	19.4	78.3±0.2	4.97±0.02
50	1.487	19.4	79.3±0.3	4.95±0.03
55	1.486	20.4	80.4±0.2	4.99±0.02
60	1.485	20.8	80.0±0.4	4.85±0.01
65	1.484	21.0	81.2±0.2	4.90±0.04

Table 2. Results of experimental procedure on sample B

Tube potential (kVp)	Refractive index (nD)	Moisture content (%H_2O)	Sugar concentration (%Brix) at 20^0	Acid values (pH)
(Control) 0	1.477	23.8	74.5±0.1	4.72±0.02
45	1.476	24.2	74.4±0.2	4.74±0.02
50	1.477	23.8	74.0±0.2	4.65±0.03
55	1.486	20.2	75.8±0.3	4.73±0.04
60	1.476	24.2	73.6±0.1	4.80±0.02
65	1.485	20.6	73.2±0.3	4.75±0.03

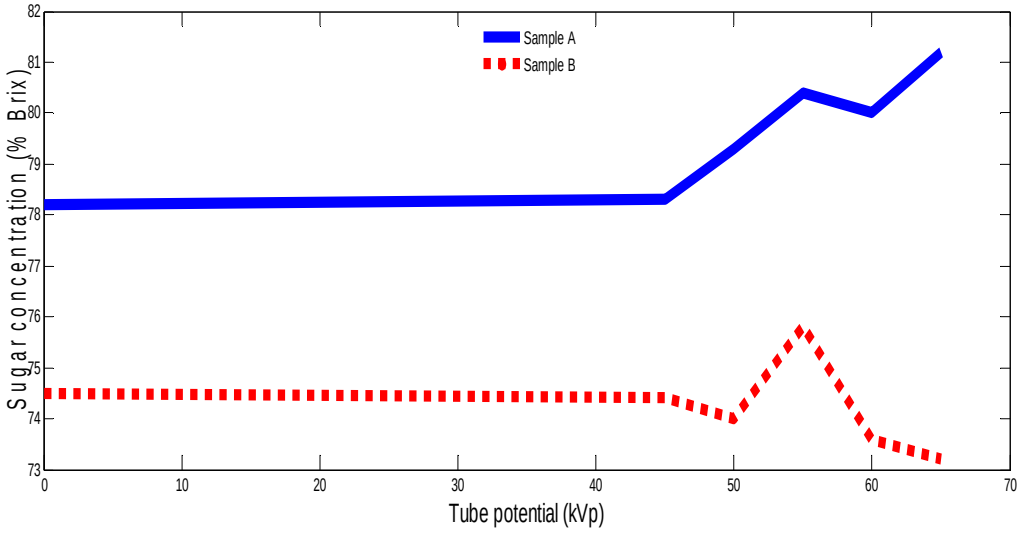

Fig.2 Variation of sugar concentration with X-ray tube potential

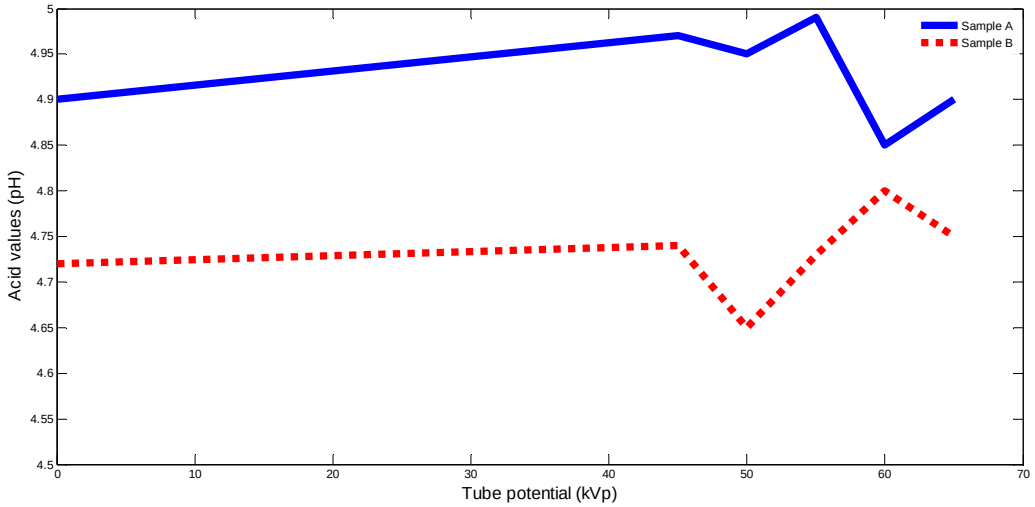

Fig. 3 Variation of acid values with X-ray tube potential

All the results of the experimental procedures carried out on the two honey samples are presented on Table 1 and 2 respectively. Table 1 shows the result of sample A, the control of the sample has a sugar concentration (SC) value of 78.2±0.4% Brix while the X-ray irradiated portions of the sample has a maximum SC of 81.2±0.2% Brix at a tube potential of 65kVp and a minimum SC 78.3±0.2% Brix at tube potential of 45kVp. The sample also has an acid value (pH) between 4.85 ±0.04 to 4.99 ± 0.02 at tube potentials of 60 and 55kVp respectively. In addition the irradiated honey undergoes a gradual increase in moisture content from 18.6% H_2O of the control to 21.0% H_2O content at the maximum exposed tube potential of 65kVp. The sugar concentration level of honey which is a saturated mixture of fructose and glucose make it to have an osmotic effect [11],[19]. Inhibition by the osmotic (water-with drawing) effect of dilute solutions of honey obviously depends on the species of bacterial [19]. Also the antibacterial activity of honey is based on its acid value [13],[19] which should be low enough to be inhibitory to many pathogens. Thus the pH value of sample A, which lies between 4.85 ±0.04 to 4.99 ±0.02 with a control value of 4.90 ±0.04 is not well suitable for use in honey therapy since the effective recommended pH for honey therapy is between 3.2 and 4.5 [6].

Table 2 shows the result of sample B the natural filtered honey obtained from Obarike Ito, Obi local Government area of Benue State. The honey has a control SC of 74.5 ±0.1% Brix while its irradiated sample has a maximum SC of 75.8 ±0.3% Brix at a tube potential of 55kVp and a minimum SC of 74.0 ± 0.2% Brix at a tube potential of 50kVp. It can be seen from Fig.1 that sample A has better SC than sample B. The acid value of the control sample is 4.72 ±0.02 while its irradiated sample has acid value ranging from 4.65 ±0.03 to 4.80 ± 0.02 at tube potentials of 50kVp and 60kVp respectively. Thus the acid values of sample B as seen in Fig. 2 are better for honey therapy than those of sample A, with this lower acid value it can act with better inhibitory quality against pathogens [13]. The moisture content of the control is 23.8% and that of the irradiated sample varies from 20.2% to 24.2% at tube potentials of 55kVp and 45kVp respectively. From Fig. 2 and 3, one can see that the measured values do not have a steady defined pattern, had values that are significant in some cases when compared with the control. This result also agrees with the work of Inyang *et al* [20] on the measurement of sugar and pH in X-ray irradiated honey.

The initial fall in the acid value of the samples when exposed to X-ray at 45kVp and 50kVp could be due to the dissociation of atomic bonds in the samples to form more water molecules which dilutes the acidity. The increase in the acidity of samples exposed at 60kVp and 65kVp could be due to the release of H^+ by the hydrolysis of water [20]

The sugar concentrations of the measured values also show variations as the pH with maximum concentration is observed when the samples were exposed to 65kVp for samples B. The decrease and increase of sugar concentration as well as moisture content of irradiated honey at different kVp, may be due to the breaking of bonds well as ionic recombination at different X-ray energies [20].

4.0 Conclusion

The work shows that sugar concentration (SC) and acid values (pH) of honey does not have a regular pattern, but had values that are significant in some cases when compared with the control. Those changes which are observed as a result of various irradiated tube potential (kVp) may be due to dissociation of atomic bonds in the samples to form water molecules as ionic recombination at different X-ray energies. Thus, there is need for caution in referring patients who are undergoing honey therapy for X-ray diagnosis.

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