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Mineral Compositions of an Edible Emulsion (Bemul-Wax) from Cassava (*Manihot esculentum*) Starch

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Short Communication

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ABSTRACT

Aims: An edible coating "bemul-wax" developed from cassava starch (*Manihot esculentum*) was examined for its safety for coating agro-crops.
Study design: Cross-sectional study.
Place and duration of study: Nigerian Stored Products Research Institute, Chemistry/ Biochemistry Laboratory, Km. 3, Asa-Dam Road, P.M.B. 1489, Ilorin, Kwara State, Nigeria., between January 2007 and July 2007.
Methodology: Some minerals component of the emulsion were assessed and compared with their recommended safety standards.
Results: The emulsion was found to contain some health beneficial mineral elements (sodium, potassium, copper, calcium, manganese, iron, and zinc) to human kind. Bicarbonate, fluorine, chlorine, nitrate, sulphate, and phosphate were also found at a level of 35.90 ± 0.09, 1.16 ± 0.04, 112 ± 3.13, 53.93 ± 2.99, 4.10 ± 0.03 and 5.64 ± 0.07 mg/L, respectively. The major minerals component of the wax emulsion were found to be calcium (108.1 mg/L), chlorine (112.93 mg/L) and to a lesser extent sodium (87.17 mg/L) and nitrate (53.93 mg/L).
Conclusion: Bemul-wax and its coated products may be considered safe for consumption from elemental point of view. It may also be a good source of health beneficial minerals.

Keywords: Emulsion; bemul-wax; safety; minerals; preservation; health benefits.

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1. INTRODUCTION

An edible films and coatings are special active part of the food, which is regarded as a foodstuff from a legal point of view, along with food packed in the film (Bhat and Bhat, 2011). Edible films can help meet the many challenges involved in food marketing (Chen and Nussinovitch, 2001). The three main categories of macromolecules often found in edible films are polysaccharides, proteins and lipids (Kester and Fennema, 1988; Chen and Nussinovitch, 2001). Hydrocolloids are used to produce thin layers of edible materials on food surfaces or between food components. Such films serve as migration inhibitors to moisture, gases, aromas and lipids, they can include antioxidants, antimicrobial agents (Kester and Fennema, 1988; Chen and Nussinovitch, 2001), preservatives or other additives to improve mechanical integrity or handling characteristics and food quality, and to change surface gloss (Chen and Nussinovitch, 2001). Hydrocolloid are often added in slight proportions (< 0.5 % w/w) to edible coatings (with wax as the major phase) to cause deliberate disturbances within the structure of the wax (i.e., to lead to a better juice taste and less off-flavours) (Chen and Nussinovitch, 2000 a, b). Wax-hydrocolloid combination creates less blockage of stomata than the coatings without gum and the commercial coating (Chen and Nussinovitch, 2001).

The main benefits of edible active coatings are their edible characteristics, biodegradability and increase in food safety. The use of films and edible coatings in food quality preservation is not a recent concept, researches in this field have recently been intensified (Geraldine et al, 2008). The factors that contribute to the renewed interest include the consumer's demand for high quality food, environmental concerns in relation to the accumulation of non-biodegradable packaging and opportunities to create new markets for the production of films from renewable resources (Geraldine et al, 2008). Edibility, biodegradability and increased food safety are the main benefits of active edible films. In the future, they will be able to replace partially or totally conventional synthetic packaging (Krochta and Mulder-Johnston, 1997).

There are different kinds of films developed from products such as protein, polysaccharide, lipid. These films can be placed on fruits and vegetables surfaces through different ways like dipping, spraying and fluidized bed systems (Ghasemzadeh et al, 2008). Some coatings were recently produced using polymeric agar-agar pure powder, with glacial acetic acid and chitosan (87% deacetylation, Polymar) used as additives (Geraldine et al., 2008). Confectionery materials such as commercial shellac, corn-zein, and wheat-gluten are also been used for coating formulations in the food processing and pharmaceutical industries (Geraldine et al., 2008).

The hazard due to the residual toxicological aspect of the inorganic chemical based waxes on man has recently become a major issue of interest, and research has begun to focus more on its development from renewable and biodegradable polymer of agricultural origin (Paramawati et. al., 2001). The recent challenges to develop a biobased wax arose as a result of new international regulation (F.A.O., 1995) due to the residual toxicity effect of the earlier commercial chemical based waxes. Consequently, several attempts had been made to develop edible wax from biobased materials culminating in products like Semperfresh, and Jonfresh (Biryindirli et al., 2007; Yang et al., 2010), Kafirin from sorghum (Emmambux et al., 2004; Gao et al., 2005), and bemul-wax from cassava starch (Afolabi et al., 2003). The bio-wax (bemul-wax), developed from liquefied cassava starch and bees wax was reported to be comparable to the Indian's commercial wax "waxol" for shelf-life extension of mandarin oranges (Afolabi et al., 2003). Its ability to preserve both the nutritional and sensory qualities of four months low temperature stored sweet oranges has also been reported (Afolabi, 2009). This could spur the exportation of sweet oranges and other agro-commodities across countries and also reducing their post harvest losses. The effect of the bemul-wax on some spoilage and defence-related enzymes in ambient temperature stored sweet potato had been reported (Afolabi and Oloyede, 2011).

The role of electrolyte in food preservation had recently been gaining attention. Electrolytes had been used successfully either alone or in combination with other preservation techniques for preservation of fruits, and fish (Poovaiah, 1986; Afolabi, 2009; Mahmoud et al., 2005). However, consumption of minerals could pose some harmful effects. Some minerals like the heavy metals had been reportedly toxic to human even at very low concentration, and their bioaccumulation can be very dangerous to the health (Al-Qurainy, 2009). These minerals could only be considered safe for consumption below their recommended levels (Lam, 2010; EUFA, 2006). There is no information yet on the mineral status of the developed bemul-wax emulsion. This led us to examine in this work the levels of minerals of this emulsion, and their possible effect on consumer of the wax treated agro-based products, having in mind that most wax treated agro-crops may be eaten directly without washing.

2. MATERIALS AND METHODS

2.1 Chemicals

Hydrogen peroxide, Sodium oleate (LR), nitric acid and sulphuric acid used in this work were product of BDH Chemicals Limited, Poole, England. Gum Acacia powder (LR) and sorbitol powder (Extrapure) (AR) were products of S.D. Fine Chemicals Ltd., India and Rolex Laboratory Reagent Chemicals, India respectively. Cassava starch was procured from two local markets (Oja Oba and Ipata) within Ilorin, and also from Ganmo local market situated at the outskirt of Ilorin metropolis, Kwara State, Nigeria. Beeswax was obtained from the Nigerian Stored Products Research Institute (NSPRI), Ilorin, Kwara State, Nigeria. All chemicals used were of analytical grade.

2.2 Bemul-Wax Preparation Method

Cassava starch 2.51 % (w/w) was weighed and suspended in a 250 ml beaker containing 70.85 % (w/w) distilled water, and 0.05 % (w/w) of sodium chloride solution. The suspension was thereafter heated to boiling point, at this stage Beeswax 1.98 % (w/w) was added and stirred manually with a stirring rod until it completely melted. Immediately after melting, a mixture of sorbitol 0.57 % (w/w), Gum arabic 0.10 % (w/w) and sodium oleate 0.33 % (w/w) that has been dissolved in 23.62 % (w/w) distilled water were added. The boiling was allowed to continue for 10 mins. The emulsion was thereafter stirred at 500 rpm for 15 mins. to obtain an emulsion with 3.967 ± 0.058 ^{o}Brix value after been allowed to cool. Three samples were prepared from the differently sourced cassava starch for mineral analysis.

2.3 Analytical Method

Digestion method (Alpha, 1985) for liquid samples was used. 10.0 ml of the bemul-wax emulsion was measured into an evaporating dish. It was thereafter acidified using concentrated sulphuric acid until methyl orange color is obtained. 5.0 ml of concentrated nitric acid (HNO_3) and 2.0 ml of hydrogen peroxide solution (30 % v/v) were thereafter added to reduce chromate. This was later heated on hot plate to allow for evaporation. The remaining solution and the residue in the dish were transferred into 125 ml conical flask. 5 ml of concentrated nitric acid, 10 ml concentrated sulphuric acid, and a few glass beads (anti-bump) were thereafter added. This was afterwards evaporated on a hot plate until dense white fumes (due to sulphite) appeared in the flask. The concentrated sulphuric acid was added again and evaporated until the sulphite fumes are formed, and a clear solution (indicating complete removal of suphite) is obtained. The clear solution was diluted to about 50.0 ml and heated to boiling point to dissolve the soluble salts present after cooling at room temperature. This was then filtered through a sintered glass crucible into a clean flask. The filtrate was transferred into 100 ml volumetric flask, and the filter flask was also rinsed twice with 5.0 ml distilled water into the volumetric flask. The solution was thereafter made up to the 100 ml mark and shaken thoroughly. An aliquot of the resultant solution (about 1.5 M sulphuric acids) was taken for metal determination using atomic absorption spectrophotometer (Philip Model sp9, UK). The method of APHA, 1985 was also followed in determination of anions like bicarbonate, ammonia, fluorine, bromine, nitrate, sulphate, and phosphate.

2.4 Statistical Analysis

The analysis was carried out for three bemul-wax sample prepared on different occasions. The mean and the standard deviation were thereafter calculated using a statistical software package.

3. RESULTS AND DISCUSSION

The mineral composition of the bemul-wax emulsion is as shown in Table 1. The emulsion was found to contain the mineral elements (sodium, potassium, copper, calcium, manganese, iron, and zinc) that could be of health benefit to human kind by promoting some important biochemical reactions in the body, and also preventing some diseases in the body. A number of these identified minerals in the bemul-wax emulsion had earlier been reported in cassava varieties (Charles et al., 2005; Adeniji et al., 2007). Our work further detected aluminium at 0.09 µg/L level, in addition to the bicarbonate, fluorine, chlorine, nitrate, sulphate, and phosphate that were not reported earlier.

These minerals were found below their permissible maximum concentrations in foods. 10 mg/L., 100 mg/L, 2.0 mg/L (20.0 in solid foods), 250 mg/L, 0.1 mg/L (1.0 in solid foods), 5 mg/L, and 1.5 mg/L are the maximum permissible levels for copper, zinc, lead, aluminium, arsenic, cadmium, and fluorine respectively (CODEX, 1963).

It was further observed that the toxic heavy metals (i.e. lead, arsenic, chromium, cadmium) were not present in the bemul-wax. This suggests the safety nature of the emulsion for treatment of agro-produce, and confectioneries in food industries. The major mineral component of the emulsion was found to be predominantly calcium (108.1 mg/L), chlorine (112.93 mg/L) and to a lesser extent sodium (87.17 mg/L) and nitrate (53.93 mg/L). These major minerals may be attributed to the preservative efficacy of the bemul-wax emulsion.

The recommended optimal daily nutritional allowance for men (*women) of some minerals are selenium (200 µg) and magnesium 300-600 mg (*500-1000 mg), chromium (200 µg), zinc (30 mg), calcium (300–500 mg (*500 mg)), iodine (150 µg), manganese (20 mg), molybdenum (50 µg), potassium (99 mg), silicon (2.4 mg), boron (2 mg) , and vanadium (25 µg) respectively (EUFA, 2006; Lam, 2010). Some of the health benefits that may be obtained from the emulsion as depicted from the minerals found in the bemul-wax may be prevention of heart diseases, cancer and arthritis; proper heart function, normalization of arrhythmia, reduction of blood pressure, enhancement of insulin resistance in Type II Diabetes, proper thymus gland and immune system function, healthy bones, maintenance of proper thyroid function, Formation of collagen and connective tissues, healthy bone and teeth, maintenance of proper brain function (EUFA, 2006; Lam, 2010). Also, the emulsion could serve as source of trace mineral essential for protein, fat, and nitrogen metabolism.

Table 1: Mineral composition of bemul-wax emulsion

Minerals (Cations)	**Concentrations** (mg/L)	**Minerals (Anions)**	**Concentrations** (mg/L)
Sodium	87.17 ± 1.34	Bicarbonate	35.9 ± 0.09
Potassium	27.14 ± 1.44	Fluorine	1.16 ± 0.04
Calcium	108.10 ± 0.23	Chlorine	112.93 ± 3.13
Magnesium	8.05 ± 0.02	Nitrate	53.93 ± 2.99
Copper	0.04 ± 0.001	Sulphate	4.10 ± 0.03
Manganese	0.03 ± 0.001	Phosphate	5.64 ± 0.07
Iron	1.15 ± 0.007	Ammonium	0.00
Zinc	0.06 ± 0.004	Bromine	0.00
Lead	0.00		
Arsenic	0.00		
Chromium	0.00		
Cadmium	0.00		
Aluminium[†]	0.09 ± 0.003		

**† unit is in µg/L*

4. CONCLUSION

Bemul-wax can be considered safe for agro-crop treatment from elemental point of view. The health of consumer may be improved since it contains a reasonable number of minerals useful for maintaining the human biochemical system.

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COMPETING INTERESTS

Authors have declared that no competing interests exist.

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