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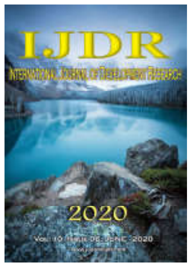

RESEARCH ARTICLE **OPEN ACCESS**

EMULSIFICATION PROPERTIES OF *ACACIA SENEGAL* GUM, GLUCURONIC ACID AND GLUCURONATES

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ABSTRACT

The present study compares the emulsifying properties of Acacia senegal gum, glucuronic acid (arabic acid) and glucuronates (arabate salts) in oil-in-water (O/W) emulsions. Emulsifying properties of each hydrocolloid were evaluated in terms of emulsion droplet-size distribution. Emulsion of Na, Ca and Mg glucuronates show stability until 3 days while Acacia senegal gum emulsion forms multiple peaks after 3 days and completely separates after 7 days. Emulsion of glucuronic acid and K glucuronate, showed no change in droplet size distribution and K shelf life during the incubation period at 60°C, that they have shown better emulsifying properties over the time range and temperature.

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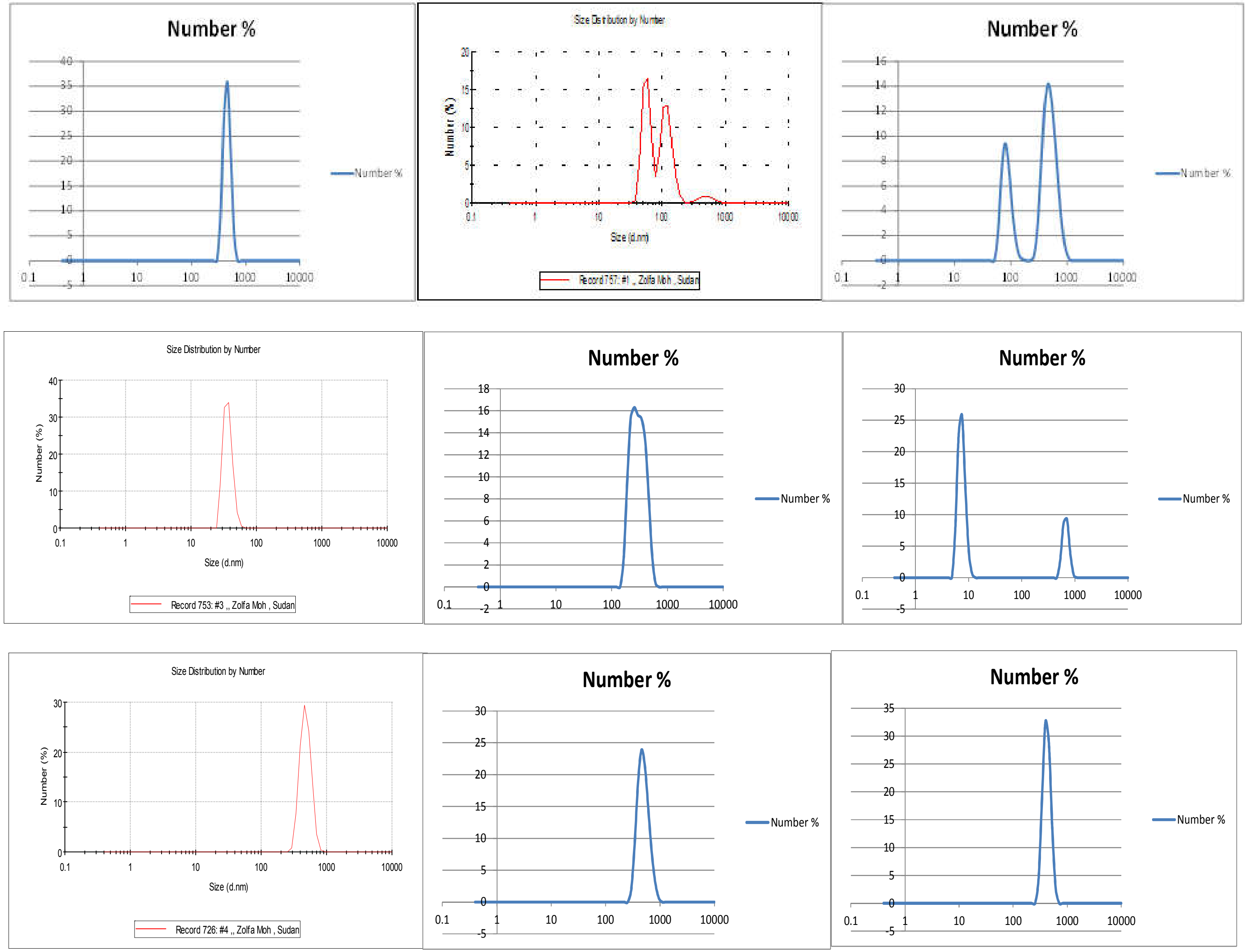
INTRODUCTION

Gum arabic is an exudate collected from the stems and branches of *Acacia Senegal* and other related African species of *Acacia*. Gum arabic is a natural polymer consists mainly of high molecular weight polysaccharides obtained as a mixed calcium, magnesium and potassium salts, which on hydrolysis yield arabinose, galactose, rhamnose and glucuronic acid (Al-Assaf *et al*., 2017; Almuslet *et al*., 2012; Mahmoud *et al*., 2014; Abaker*et al*., 2014). It is the least viscous and most soluble of the hydrocolloids, and is used extensively in the industrial sector because of its emulsification, film forming and encapsulation properties (Yassen *et al*., 2014). Two types of gum arabic *Acacia Senegal* and *Acacia seyal* are commercially distributed in the market. *Acacia Senegal* has good emulsification properties for oil - - in water emulsions and is widely used in emulsion applications (Nishino *et al*., 2012).

An emulsion is a dispersed system that consists of two immiscible liquids (usually oil and water), with one of the liquids dispersed as small droplets in the other called continuous phase stabilized by presence of emulsifying agent. The emulsions are thermodynamically unstable systems and have a tendency to break over time (Surajudeen Abdulsalam, 2015). Emulsions form the basis of a wide variety of natural and manufactured materials used in the food, pharmaceutical and cosmetic industries. Existing and new ingredients are, regularly, incorporated into food systems to improve their rheological, physicochemical and nutritional properties (McClements, 2008). These ingredients, however, may sometimes, slowly, degrade and lose their activity, undergo oxidation, react with components present in the food system which may limit their bio-availability, or change the color or taste of a product making it necessary that they be stabilized (Schrooyen, 2001).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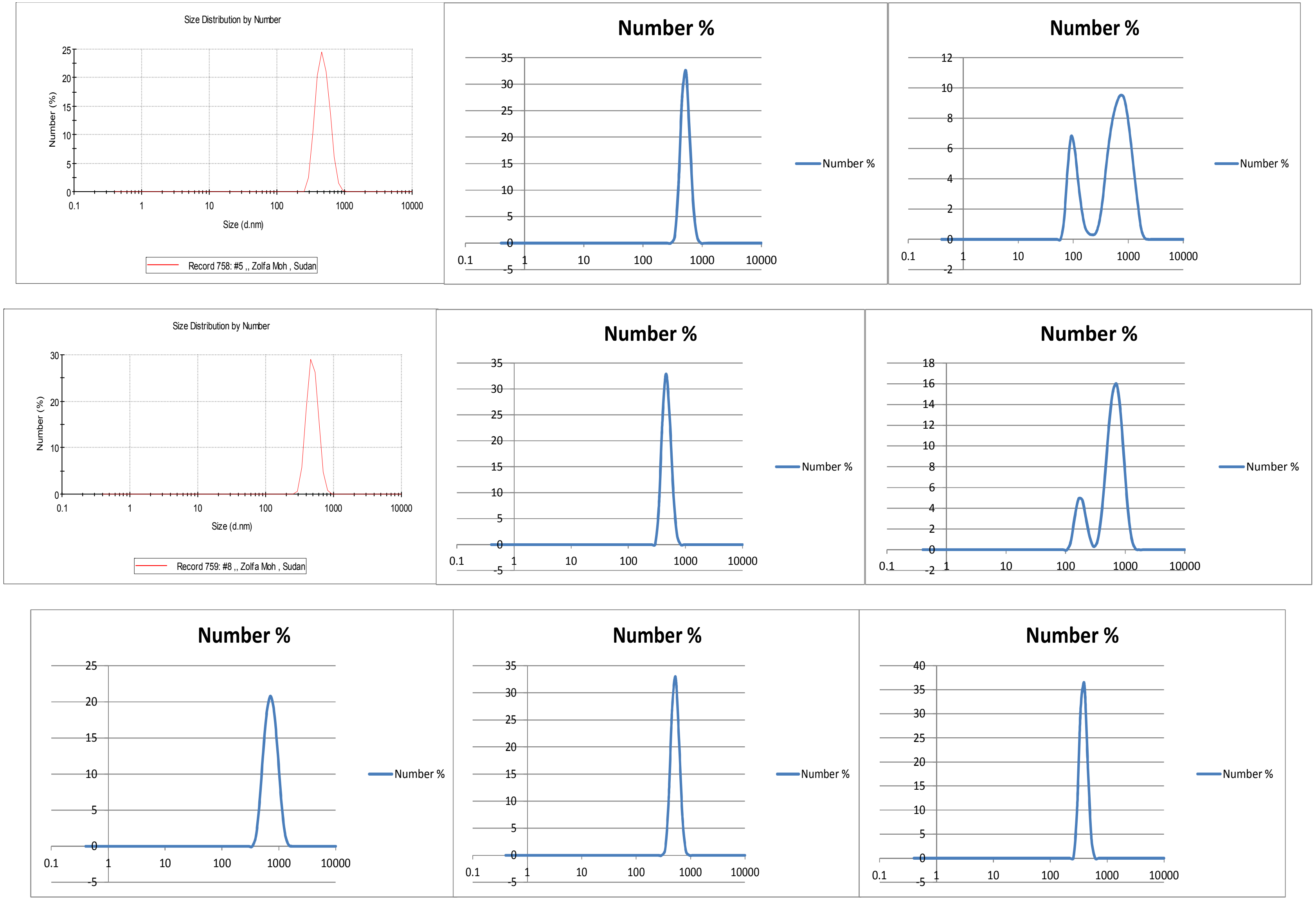

(a) Freshly prepared **(b) after 3 days** **(C) after 7 days**

Figure (3.6). Particle size distributions of glucuronic acid emulsion as freshly prepared, stored for 3 and 7 days at 600C.

One of the major concerns for emulsions is keeping the emulsion droplets uniformly distributed during storage and consumption such as K glucuronate which has longer shelf life as shown in this study. This has led the food industry and many researchers to investigate the ability of hydrocolloids and proteins to stabilize emulsion against creaming, flocculation and coalescence, depending on their intended application (Sabah *et al*., 2008). Previous studies have also shown that the stability of (O/W) emulsions depends on both the type and concentration of ingredients contained in the emulsion as well as processing and storage conditions (Ali *et al*., 2013). At present, gum arabic is one of the most widely used biopolymers in foods and beverages (Randall, 1989; Dickinson, 2009). Its arabinogalacto protein (AGP) component is responsible for its unequalled emulsifying properties, including the ability to form stable emulsion over a wide pH range and in the presence of electrolytes (Islam *et al*., 1997; Buffo *et al*., 2015). The purpose of this work was to study and compare emulsion properties and droplet stability of*Acacia senegal*, glucuronic acid and glucuronates salts.

MATERIALS AND METHODS

Materials

The gum arabic (*Acacia senegal*), collected from Blue Nile state (Eddamazin); 2009. Glucuronic acid and glucuronates salts as prepared in paper (Abaker *et al*., 2014).

Equipment

The equipments used in this study were:

- Bench-top high-speed mixer (Wise Tis model Tis Tis, 26.000 rpm, USA).
- High pressure homogenizer Ultra-sonicator (JEIOTECH, UC – 10, UK)
- Zeta Sizer Nano Zs (Malvern Instruments, UK)

Methods

Preparation of glucuronic acid (Arabic acid) and glucuronates (arabate salts)

As prepared in paper (Abaker *et al*., 2014).

Emulsion preparation: Emulsion of *Acacia senengal* gum, glucuronic acid and glucuronates were prepared using: orange oil 6.5%; *Acacia senegal*, glucuronic acid and glucuronates 20%; sodium benzoate andcitric acid 0.1%; 0.4% respectively as preservative and deionized water 73.4% (Buffo *et al*., 2001). Solutions of 25% (w/w) were prepared from *Acacia senengal* gum, glucuronic acid and glucuronates by hydratedovernight and, gentle, mixing to complete dissolution. Emulsion was prepared by adding all the components and homogenizing with a bench-top high-speed mixer (Wise Tis model Tis Tis, 26.000 rpm, USA) for 5 minutes. Fine emulsification was achieved by subjecting the emulsion to a high pressure homogenizer Ultrasonicator (JEIOTECH, UC – 10, UK).

RESULTS AND DISCUSSION

Emulsification properties of *Acaciasenegal*gum, glucuronic acid and glucuronates were determined by measuring particle size distribution for freshly prepared emulsion and after 3 and 7 days using Zeta Sizer Nano Zs (Malvern Instruments, UK, particle size distribution analyzer). Figures 3.1 to 3.6 show the average size emulsion droplets for *Acacia senengal* gum, glucuronic acid and glucuronatessalts at different conditions (fresh emulsions and after storage for 3 and 7 days at 60^{o}C respectively). Results show that change in droplet size take place during the incubation for 7 days at 60^{o}C. The emulsion of Na, Ca and Mg glucuronatessalts show stability until 3 days while *Acacia senengal* gum forms multiple peaks from 3 days and completely separated in 7 days. The emulsion of glucuronic acid and K glucuronatesclearly show that no change was found in most emulsions during the incubation for 7 days at 60^{o}C which means that glucuronic acid and K glucuronateare most stable emulsion over the incubation period and temperature. The order of stability is glucuronic acid, Kglucuronate>N glucuronate> Caglucuronate> Mgglucuronate> *Acacia senegal*gum. The explanation for the stability of glucuronic acid refer to very small size of glucuronic acid which make the molecule very compact; in addition to the fact that the present of hydroxyl groups in glucuronic acid molecule are responsible for the production of oil-in- water emulsion. In the univalent glucuroniates mainly in the case of K glucuronate containing hydroxyl groups, the packing of the emulsifying agent molecules need not be altered because the polar metallic atoms, and also the polar hydroxyl groups dip into the water giving ability of good emulsion; in addition it is probable that the presence of so many polar groups in the molecule makes the production of emulsions of oil-in-water possible. Also the optimum size of K glucuronate compared with other cations is additional reason. For Na glucuronate completely face separation was notice after 7 days. However, when a divalent metal attacked to glucuronic acid molecule, the hydroxyl groups increase the magnitude of the hydrocarbon chain that there is little tendency to curvature, and the emulsions obtained are less stable and this obtained by Ca and Mg glucuroniates. For *Acacia senegal* gum it is begin to form 3 peaks from 3 days and this refer to its arabinogalacto protein (AGP) component which responsible for its unequalled emulsifying properties. The emulsifying powers for all samples are equal but the emulsifying stability is different among them with time.

Conclusion

The emulsifying properties study of the gum arabic, glucuronic acid and glucuronates salts, clearly, show that glucuronic acid and K glucuronates form more stable emulsion than *Acacia senegal* gum, Na, Ca and Mg glucuronates. The order of stability is glucuronic acid, K glucuronate> N glucuronate> Caglucuronate> Mg glucuronate>*Acacia senegal*gum.

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