

# **SAIB - The Oldest New Ingredient for the Beverage Market**

Stephen J. Byrd  
Technical Service Technologist  
Eastman Chemical Company

## **Introduction**

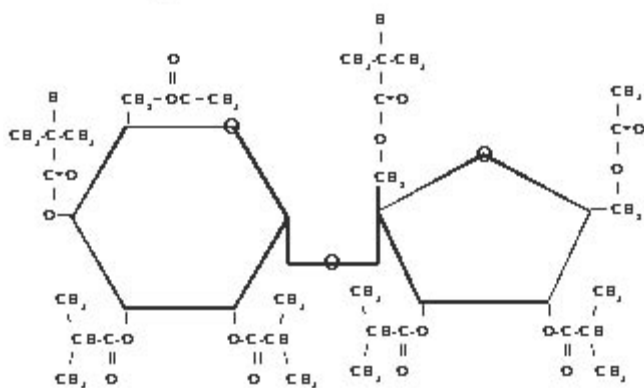
Citrus beverages have been a rapidly growing segment of the beverage market, having shown double-digit growth for most of the past several years. Carbonated beverages, fruit punches, sports drinks, and premixes are among the products that make up this portion of the beverage market. Citrus beverages typically use essential oils, derived from the peels of citrus fruits, as a primary part of their flavor system. Given that the specific gravities of these oils are less than those of the finished beverages in which they are used, stability of the beverage is a continual concern. Oil droplet size and specific gravity are two factors that can be varied to improve stability. Chemical compounds called weighting agents are often blended with the essential oils to produce an oil phase that has a higher specific gravity than the essential oil alone. These materials are lipophilic compounds with a specific gravity of greater than one. Such weighting agents should be easily miscible with flavoring oils and should not affect the flavor of the beverages in which they are used. Sucrose acetate isobutyrate or SAIB is such a weighting agent.

I realize that it may be asked, "What is so new about SAIB? Its use in beverages has been known for years." SAIB has been used in beverages in various countries for over 25 years. However, it was not until June 1999 that SAIB was approved for use in non-alcoholic beverages for the United States. In light of this fact, we at Eastman Chemical Company like to refer to SAIB as the oldest new ingredient for the beverage market.

## **What is SAIB?**

SAIB is classified as a sucrose ester, sucrose diacetate hexaisobutyrate (Figure 1). It is produced by a controlled esterification process, in which sucrose is reacted with acetic anhydride and isobutyric anhydride. The excess anhydrides and acids are stripped off and the SAIB is further purified by molecular distillation.

**Figure 1. Chemical Structure of SAIB**



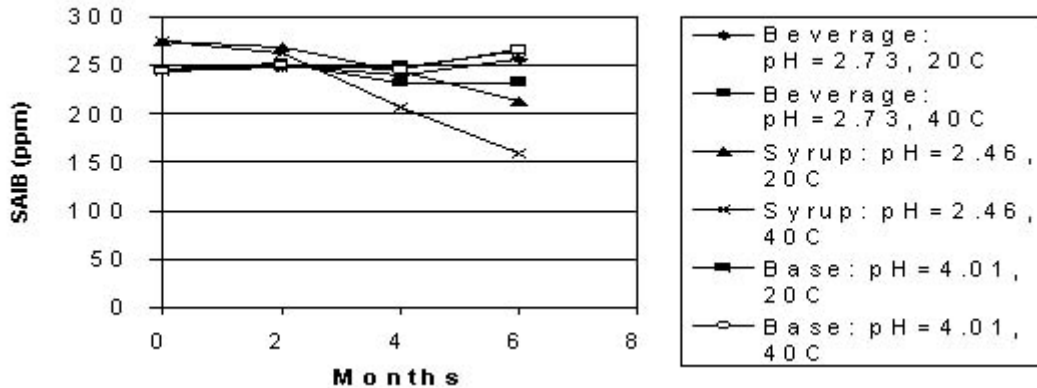
SAIB is a clear liquid with a viscosity of 100,000 centipoise (cps) and a specific gravity of 1.146 at 25° C. The molecular weight of SAIB is about 845 and it has a refractive index of 1.454 (Table 1). SAIB is very soluble in flavoring oils and various solvents such as orange terpenes, ethanol, and medium chain triglycerides. Being fully saturated, it has excellent oxidative stability with a shelf life of two years.<sup>1</sup>

**Table 1. Typical Properties of SAIB**

|   |
|---|
| Molecular Weight Range 832-856            |
| Color, Gardner Scale 1                    |
| Refractive Index, n <sub>20/D</sub> 1.454 |
| Specific Gravity @ 25° C/25° C 1.146      |
| Weight/Volume                             |
| Kg/L 1.14                                 |
| Lb./gal (U.S.) 9.55                       |
| Lb./gal (Imperial) 11.46                  |
| Flash point, Tag Closed Cup, ° C 226      |
| Decomposition Temperature, ° C 288        |
| Solubility in Water @ 25° C, wt% 0.1      |
| Shelf Life, years 2                       |

A study was conducted by Eastman Chemical Company to determine the stability of SAIB in beverages. This study was performed at various values for pH (2.46, 2.73, 3.23, and 4.01) and temperatures (20° and 40° C). Changes in SAIB content were monitored over a period of six months. Figure 2 summarizes data for beverages, syrups, and emulsions at typical pH values. SAIB was very stable under all conditions for two months. Minimal degradation of SAIB was observed in the beverages and beverage bases (emulsion) for the six-month test period.

**Figure 2. Stability of SAIB**



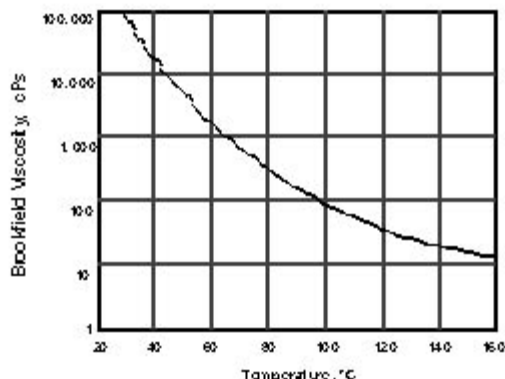
Some degradation was observed in the syrup stored longer than two months, especially at the high temperature, but was considered to be acceptable given the harsh test conditions. It was concluded that SAIB was stable under normal conditions, and retained acceptable stability even at excessively high storage conditions.

SAIB is odorless and flavorless at typical beverage levels. This advantage coupled with the excellent oxidative stability of SAIB minimizes the possibility of off-flavors in the beverage in which it is used, resulting in a cleaner, fresher taste. The good solubility of SAIB in solvents such as ethanol allows for easier equipment cleanup. SAIB has a higher specific gravity than any other weighting agent except brominated vegetable oil (BVO). This allows for more flexibility in the weighting of the oil phase.

### **Handling of SAIB**

The most commonly stated disadvantage of SAIB is its physical form. SAIB is a viscous liquid that requires heating to improve its flow properties (Figure 3). Heating SAIB to about 60 to 70° C reduces its viscosity to 1000 cps and it becomes a free-flowing liquid. This can be accomplished through the use of drum heaters.

**Figure 3. Viscosity Of SAIB vs Temperature**



However, heating SAIB is not always practical. An alternative approach of lowering the viscosity of SAIB is to dilute the material with a food-grade solvent such as ethyl alcohol or orange terpenes. A blend of 90% SAIB and 10% ethanol is a free-flowing liquid at ambient temperature with a viscosity of about 1000 cps. A blend of SAIB containing 10% orange terpenes is also a free-flowing liquid at ambient temperature with a viscosity of about 3000 cps. Other suitable solvents include propylene glycol diesters and medium chain triglycerides.<sup>2</sup>

### **Formulating with SAIB**

Flavor oil phases that contain SAIB are typically weighted to a specific gravity of about 0.98 to about 1.00.<sup>3</sup> This will give ratios of SAIB to flavoring oil of about 1:1 to about 1.7:1. Spray-dried gum arabic or octenyl succinylated food starches are suitable for use as emulsifiers. The emulsion should be homogenized to obtain a particle size of one micron or less. This can usually be achieved after two passes through a two-stage homogenizer using pressures of about 3000 to about 4500 PSI, depending on the type of emulsifier used. Table 2 describes a basic citrus beverage emulsion formulation.

**Table 2. Basic Citrus Beverage Emulsion Formulation**

Flavor Oil 2-5%

SAIB-FG 2-8%

Emulsifier 10-20% (14-20% gum arabic or 11-16% modified starch)

Citric Acid 0.15%

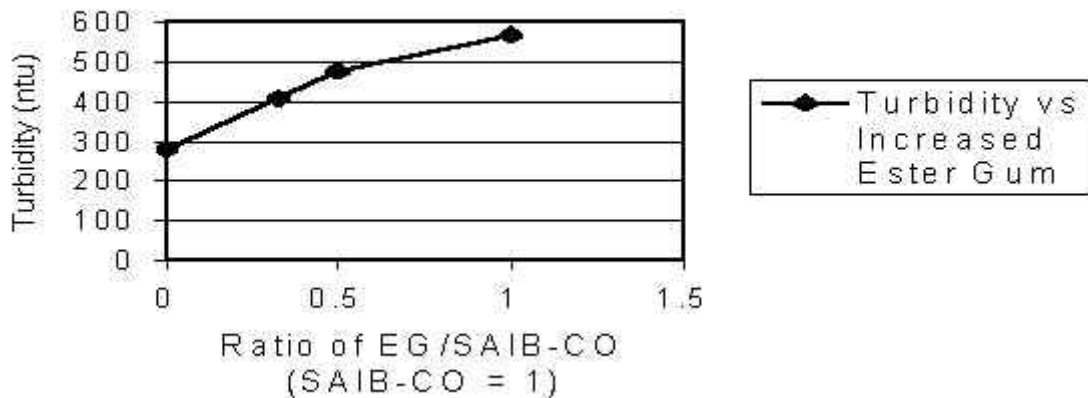
Sodium Benzoate 0.10%

Water QS to 100%

SAIB imparts less turbidity to the beverage than do other weighting agents. Turbidity can be increased through the use of neutral clouding agents such as vegetable oils or medium chain triglycerides (MCT). Vegetable oils should be mixed with medium chain triglycerides in a proportion of about 3 parts vegetable oil to 1 part MCT to increase ease of blending (Eastman Chemical Company, unpublished data).

Ester gum can also be blended with SAIB to increase turbidity. The ester gum can be dissolved in the flavoring oil prior to adding the SAIB or it can be dissolved into SAIB heated to 90° C. Figure 3 shows the effect of added ester gum on beverage turbidity. The emulsions from which the beverages were prepared contained 3% flavoring oil with the oil phase weighted to a specific gravity of 0.99. A blend 90% SAIB and 10% orange terpenes (SAIB-CO) was used as the weighting agent. The emulsions contained 18% gum arabic and 0.31% dioctyl sodium sulfosuccinate (Eastman Chemical Company, unpublished data).

**Figure 3. Increased Turbidity with Added Ester Gum**



In countries where its use is permitted, the stability of emulsions containing acacia gum can be improved by the addition of 6-8 parts per million of dioctyl sodium sulfosuccinate (DSS), based on the final beverage. DSS also increases the cloud of the beverage as emulsions that contain it have a reduced particle size. DSS should be added to the flavoring oil prior to addition of SAIB or it can be added to the oil phase as a 50% solution in propylene glycol or ethanol.

### **Regulations and Safety**

In February of 1996, The Joint Expert Committee on Food Additives set an ADI of 20mg/kg for SAIB.

Eastman Chemical Company, with assistance from the International Life Sciences Institute (ILSI, Washington, D.C.), submitted toxicity studies performed in several species of animals for review by the Food and Drug Administration. These studies included absorption, metabolism, and elimination studies and were performed in rats, dogs, rabbits, monkeys, and humans. Short term studies, a palatability study, subchronic studies, chronic studies, carcinogenicity studies, reproductive studies, teratology studies, genotoxicity tests, and liver function studies were also performed in several species including mice, rats, dogs, rabbits, monkeys, and humans.

Doses of up to 0.02g/kg/bw/day were used for 14 days. This dose would be equivalent to drinking 4 liters per day of a beverage containing 300 ppm SAIB. The results of the human clinical studies indicated that SAIB is not toxic to humans.

SAIB is metabolized to sucrose, acetic, and isobutyric acids. These compounds are found in many of the foods that we consume every day. Metabolic studies indicate that the primary urinary metabolites in humans are lower acylated sucroses and free sucrose.

The FDA concluded that SAIB would not be harmful when used as an emulsion stabilizer for flavoring oils in non-alcoholic beverages and is therefore safe for its proposed use. On June 4, 1999 the Food and Drug Administration approved SAIB under 21CFR Part 172.833(b). It is approved for use in non-alcoholic beverages at a maximum level of 300 parts per million in the finished beverage.<sup>4</sup>

SAIB is regulated at the highest level of any approved weighting agent consistent with its demonstrated safety<sup>5-7</sup> and is approved globally on more than 40 countries (Table 3).

**Table 3. Countries that Permit the Use of SAIB in Beverages**

|           |                |              |               |
|-----------|----------------|--------------|---------------|
| Argentina | Czech Republic | Kenya        | South Korea   |
| Australia | Cyprus         | Mexico       | Taiwan        |
| Barbados  | European Union | New Zealand  | Tanzania      |
| Brazil    | Iceland        | Nigeria      | Thailand      |
| Canada    | India          | Norway       | United States |
| Chile     | Israel         | Paraguay     | Uruguay       |
| China     | Jamaica        | Philippines  | Venezuela     |
| Colombia  | Japan          | South Africa | Zambia        |

Labeling requirements vary depending upon the regulations of the particular country. In the United States, SAIB can be listed as SAIB or sucrose acetate isobutyrate. In the European Union countries the label designation for SAIB is E 444. In countries using the International Numbering System, the label designation is INS 444. Some countries permit label declarations such as sucrose esters or sucrose fatty esters.

Regulatory approvals are pending in Costa Rica and Indonesia.

## **Summary**

SAIB is a beverage-weighting agent suitable for use in a wide range of citrus-type beverages, ranging from carbonated beverages to sports drinks. It can also be used in neutral cloud emulsions. The higher specific gravity of SAIB allows for greater flexibility in weighting the flavoring oil. With its bland taste and excellent oxidative stability SAIB imparts no significant taste to the beverage, even at the maximum levels allowed. Extensive studies have shown SAIB to be safe, allowing it to be regulated at the highest level of any weighting agent. Numerous studies have shown SAIB to be safe, resulting in its approval on a global basis. Its safety, bland taste, and high specific gravity combine to make SAIB an excellent weighting agent.

## **References**

1. Anon, Eastman SAIB-SG for Beverage Applications, Publication ZM-100, Eastman Chemical Company, Kingsport, TN, 1998.
2. Henry C., Reducing the Viscosity of SAIB-SG with Food Grade Diluents, Eastman Chemical Company Technical Report, 1996.
3. Lopez P., Preparation of Orange Flavored Beverages Using Sucrose Acetate Isobutyrate - Special Grade (SAIB-SG), Eastman Chemical Company Technical Report, 1999.
4. U.S. Food & Drug Administration, Sucrose Acetate Isobutyrate, Code of Federal Regulations, Title 21, Section 172.833(b).
5. Chiang M., Gray K. and Chappel C.I., Effect of sucrose acetate isobutyrate (SAIB) ingestion on the hepatobiliaryfunction of normal human male and female volunteers, *Food Chem. Toxicol.* 1998 Feb; 36(2): 141-4.
6. Procter B.G. and Chappel C.I., Subchronic toxicity studies of sucrose acetate isobutyrate (SAIB) in the rat and dog, *Food Chem. Toxicol.* 1998 Feb; 36(2):101-10.
7. Reynolds R.C., Metabolism and pharmacokinetics of sucrose acetate isobutyrate (SAIB) and sucrose octaisobutyrate (SOIB) in rats, dogs, monkeys or humans: a review, *Food Chem. Toxicol.* 1998 Feb; 36(2): 95-9.