FLOW BEHAVIOR OF SOME FRUIT JUICES

By

Mariam Mohamed Adel Mohamed Zaki El-Menawy

A Thesis Submitted to the
Faculty of Engineering at Cairo University
In Partial Fulfillment of the
Requirements for the Degree
MASTER OF SCIENCE
In
Chemical Engineering

FACULTY OF ENGINEERING, CAIRO UNIVERSITY

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Under the Supervision of

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Disclaimer

I hereby declare that this thesis is my own original work and that no part of it has been submitted for a degree qualification at any other university or institute

I further declare that I have appropriately acknowledged all sources used and I have cited them in the references section

Name: Mariam Mohamed Adel Mohamed Zaki El-Menawy

Date: 3rd November 2018

Signature:

Dedication

To my dad, may your soul rest in peace. I wish you were among us to witness it

To my mother and my super hero. I wouldn’t have gone that far without you

To my backbone and blessing, my sister & brother (Sarah & Sherif) for their endless support

To my husband (Youssef) who continuously motivated me, supported me & kept pushing me whenever I stopped working

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Nomenclature

τ	Shear Stress, Pa
$\dot{\gamma}$	Shear Rate, sec -1
μ_{app}	Apparent Viscosity, Pa.Sec
τ_0	Yield Stress, Pa
k	Consistency Factor
n	Flow Behavior index
T	Temperature, °C
E	Activation Energy
a_o	Empirical Constant
a_1	Empirical Constant
a_2	Empirical Constant

Abstract

Juice production is known to be one of the important and critical industries as it involves products that are delivered and consumed by people. Strict parameters should be maintained in order to deliver safe product from raw materials delivery and semi-finished product processing to end product handling. The demand for juice in Egypt has increased widely to call for new product innovations and concepts since it is a country with high potentials of market growth.

Upon processing juice, identifying the juice type whether it's high on fruit content, artificial fruit drink or juice mix is mandatory as it strongly assists in identifying the optimum processing parameters. Juice production schemes can differ depending on whether the starting point is production from juice concentrate or juice fruit.

The fluid behavior in each processing step starting from ingredients mixing up to heat treatment should be known as it serves in the ideal handling for the juice and maintaining the product quality. This results in providing premium juice for end consumer and can be studied through Rheology. Rheology is the study of flow behavior and deformation of fluid upon applying certain force and analyzing the flow behavior in response to time, temperature change and deformation

The purpose of this thesis is to study the fluid behavior of both Mango and Guava juice in preliminary mixing, product homogenization and final heat treatment. For both juices, the rheological study was conducted from range 10-105 °C using Brookfield Rheometer with speed of spindle ranging from 10-100 rpm.

For Mango Juice, fruit content was constant at 15%. After mixing at both temperature 10 & 18 °C the fluid behavior follows a Bingham fluid. the increase in temperature from 10 to 18 °C has had for effect to decrease the yield stress and the limiting viscosity. After homogenizing at temperature range (50-103 ºC), temperatures a shear thinning behavior was observed approaching a zero viscosity at infinite shear rate. A thixotropic behavior can be observed as evidenced by the presence of a hysteresis loop. Finally, the cooling step for mango juice at temperature range (65-20°C) gave the straight lines indicating prevalence of Bingham behavior with a decrease in the consistency index (Limiting viscosity). While also observing a thixotropic behavior as evidenced by the presence of a hysteresis loop.

For Guava Juice, fruit content was constant at 25%. After mixing at both temperature 10 & 18 °C the fluid behavior follows a Shear Thinning behavior. After homogenization At temperature range (50-80 ºC), The best fits of data showed then displaying Bingham fluids behavior approaching limiting viscosities at infinite shear rate. A thixotropic behavior can be observed as evidenced by the presence of a hysteresis loop. Finally, the cooling step at temperature range (65-20°C) gave the straight lines indicating prevalence of Bingham behavior with general decrease in yield stress. While also observing a thixotropic behavior as evidenced by the presence of a hysteresis loop.

Chapter 1: Introduction

Juice production is known to be one of the important and critical industries as it involves products that are delivered and consumed my people. Strict parameters should be maintained in order to deliver safe product from raw materials delivery and semi-finished product processing to end product handling.

Currently, diverse trends for juice mixes are available such as: juice and milk mix, fruit and vegetable mix, culture drinks and healthy drinks. Some producers also advertise 100% natural juice that is not made from concentrate. For example, Cawtson Press juice range claims that it consists of pressed original fruits and vegetable blends with no added sugar, no sweeteners, no coloring and no preservatives. Likewise, healthy people range claims for its mango and acerola super fruit that it is a main source of antioxidants as it includes both vitamin C and vitamin E.

In 2012 -2013, Germany scored the highest in juice consumption worldwide and maintained almost the same consumption rate across EU region in 2016 according to Statista EU per capita consumptions in litres. [1] (Fig 1.1)

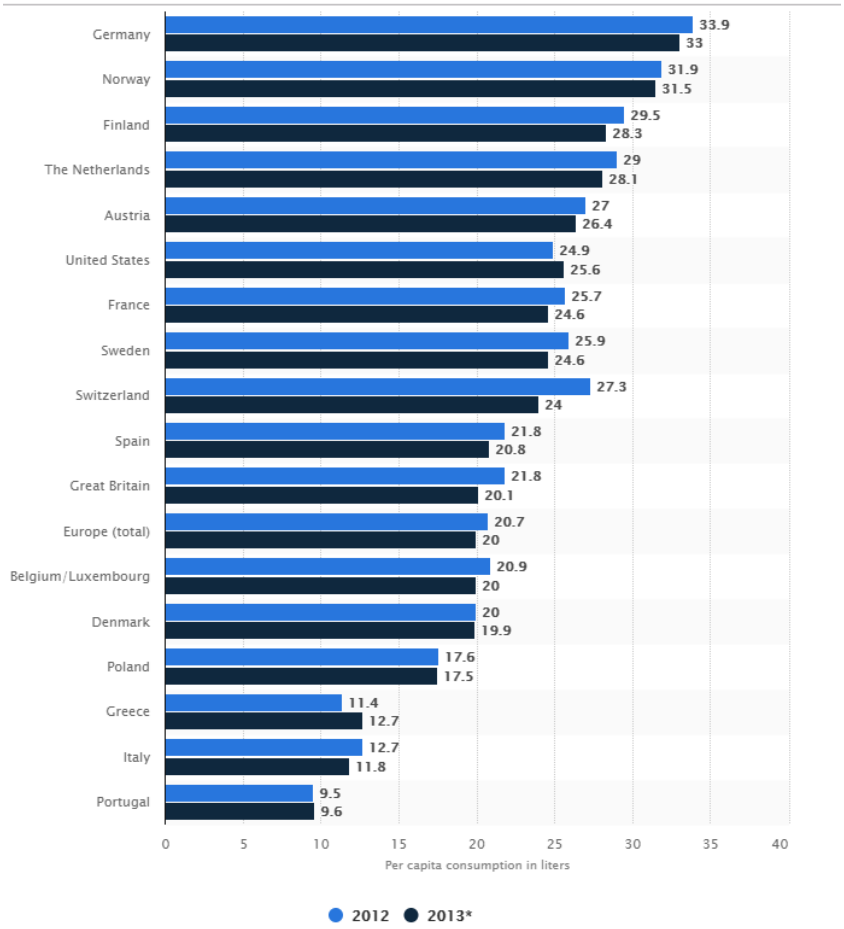

Figure 1-1 Juice Consumption Rate across EU in accordance with U.S