# Optimization in production of yogurt enriched with phenolic compounds of carob pulp (*Ceratonia siliqua* L.) by experiment plan

Yassine Benchikh[1, 2*], Iliès Kadda Djellas[1], Nassima Mohellebi[3]
*1: Département de Biotechnologie, Institut de la Nutrition, de l'Alimentation et des Technologies Agro-Alimentaires (I.N.A.T.A.A.), Université Frères Mentouri – Constantine 1, 25000 Constantine, Algeria.* yassine.benchikh@umc.edu.dz
*2 : Laboratoire de Biochimie Appliquée, Faculté des Sciences de la Nature et de la Vie, Université de Bejaia, 06000 Bejaia, Algeria.*
*3 : Laboratoire de Microbiologie Appliquée, Faculté des Sciences de la Nature et de la Vie, Université de Bejaia, 06000 Bejaia, Algeria.*

**Abstract**
***The present work concerned the enriching of a homemade yogurt with the phenolic compounds of the carob pulp (Ceratonia siliqua L.) and the optimization of its production by following, particularly, the pH and the viscosity.***
***For this, a central composite plan was chosen, fixing the volume of the added aqueous carob extract (VACE) and the incubation time. These are the two influencing factors of the production of yogurt. The extraction of phenolic compounds (CP) was achieved by decoction. The CP contents and the antioxidant activity (AA) of the obtained extract were 1.71 ± 0.01 g GAE (Gallic Acid Equivalent) / 100 g DM (Dry Matter) and 79.4 ± 0.01%, respectively. From this extract, 3 VACE of 150, 300, and 450 mL were adjusted to 1 L of milk for the production of yogurt and a sample was left as a control.***
***The optimal conditions to produce a yogurt enriched with phenolic compounds were 446.55 mL for the VACE and 6.95 h for the incubation time. According to the obtained results there was 0.99 g GAE of phenolic compounds in a liter of processed yogurt.***

***Keywords:*** *carob pulp extract, yogurt, phenolic compounds, optimization, central composite plan.*

## I. Introduction

The carob tree is ancestral with very controversial origins and its presence in the Mediterranean basin dates back to the Neolithic era (4000 years BC). Perennial evergreen tree, thermophilic, xerophilic and heliophilous, it tolerates poor soils, drought, and even salt (NaCl) concentrations up to 2.32 g/L [1, 2]. In addition to its characteristics, the carob fruit has very advantageous properties such as being rich in sugars, in fibers, in mineral salt, in phenolic compounds, and in antioxidants.

Carob has multiple and various uses and affects different sectors, moving from cattle feed to the food, cosmetic, pharmaceutical industry and even the manufacture of explosive devices [3].

Algeria is one of the first carob producers in the world (FAO, 2014). This resource deserves to be valued by using it as an ingredient in food matrices such as yogurt which is a widely consumed dairy product, appreciated by a wide range of consumers. It is an essential source of protein, especially in underprivileged areas, for children and the elderly persons, and also an important source of calcium.

Since a long time many studies and research works having carried out concerning this subject so that the manufacturing processes and the yogurt technology are perfectly mastered. In addition it has the ability to be a very good support to be incorporated into the daily diet, among food products such as fruits and cereals or added value products like honey and bacteria which enter into the regulation of digestion and intestinal transit. This ability was the motivating factor to develop one of the carob by-products which was its pulp, rich in phenolic compounds [4]. Several studies have demonstrated the beneficial physiological effects of these phenolic compounds on improving health and/or well-being as well as reducing the risk of developing certain diseases. Among others, their antioxidant properties, their anti-inflammatory, nephro-protective and gastro-protective, anti proliferative and apoptotic effects on human cancer cells, can be cited [5-10].

The idea of this work was to extract its phenolic compounds, using a method of extraction by decoction, an effective, a non expensive, an economical and a very simple method which could in no case have a negative impact on health when enriching the yogurt with this extract to give it an added value in phenolic compounds. This enrichment must be optimized so as to incorporate the maximum of phenolic compounds while