IOCAG 2022

MDPI

Proceeding Paper

Elaboration of New Functional Dairy Dessert Based on Flaxseed Powder †

Benahmed Djilali Adiba [1,2,3], Benseddik Abdelouahab [4], Metahri Mohammed Said [1], Lahouazi Dyhia [1], Simoud Dyhia [1], Nabiev Mohamed [5] and Allaf Karim [3]

[1] Faculty of Biological and Agricultural Sciences, University Mouloud Mammeri of Tizi-Ouzou, Tizi-Ouzou 15000, Algeria; (B.D.A.); (M.M.S.); (L.D.); (S.D.)
[2] Laboratory of Research Unit, Materials, Processes &Environment (UR-MPE), University of Boumerdes, Boumerdes 35000, Algeria
[3] Laboratory of Engineering Science for Environment LaSIE-UMR-7356CNRS, University of La Rochelle, 17000 La Rochelle, France; (A.K.)
[4] Unité de Recherche Appliquée en Energies Renouvelables, URAER, Centre de Développement des Energies Renouvelables, CDER, Ghardaia 47133, Algérie; (B.A.)
[5] Laboratory of Petrochemical Synthesis FHC, University M'Hamed Bougara of Boumerdes, Boumerdes 35000, Algeria; (N.M.)
* Corresponding author: adiba.benahmed@yahoo.fr
† MOL2NET, International Conference on Multidisciplinary Sciences. 1st International Online Conference on Agriculture—Advances in Agricultural Science and Technology

Abstract: The objective of this work is the evaluation of some biochemical, pharmacological and nutritional properties of flaxseed (*Linum usitatissimum* L.) with a view to its application as a dairy dessert. Five dessert formulations were developed by substituting the milk powder and the carrageenan gelling agent with flaxseed powder. Biochemical analysis and sensory quality assessment of the different formulations were carried out. The results of the phytochemical analysis show that flaxseed is rich in bioactive substances, namely flavonoids, carotenoids, alkaloids, tannins, quinines and mucilage. The extraction yield of the latter is of the order of 7.08%. In addition, it is rich in unsaturated fatty acids: linolenic acid (52.69%), linoleic acid (15.96%) and oleic acid (20.21%). The evaluation of the antioxidant activity of the aqueous extracts and mucilage of this seed, carried out using the DPPH free radical scavenging method, indicated that the two extracts showed considerable antioxidant activity of, respectively, 18.97 ± 4.27% and 12.31 ± 4.96% at a concentration of 0.025 g/mL (crude extract). Formulation F1, composed of 50 g of flaxseed powder without cocoa, was chosen as the best formulation by tasters for its texture, smell, taste and color. It is also rich in flavonoids. Dairy dessert based on flaxseed powder could be considered as a new functional dessert containing healthy food.

Keywords: *Linum usitatissimum* L.; bioactive substances; DPPH; dairy dessert

Citation: Adiba, B.D.; Abdelouahab, B.; Said, M.M.; Dyhia, L.; Dyhia, S.; Mohamed, N.; Karim, A. Elaboration of New Functional Dairy Dessert Based on Flaxseed Powder. *Chem. Proc.* **2022**, *4*, x. https://doi.org/10.3390/xxxxx

Academic Editor(s):

Published: date

Flaxseed

Dairy desserts based flaxseed powder

1. Introduction

Linum usitatissimum L. is a plant that belongs to the *Linaceae* family (Abidi et al. 2019). It is classified among medicinal plants because of its healing properties, and it is known for its richness in bioactive molecules (flavonoids, proteins and essential fatty acids, lignan, vitamins, minerals, soluble and insoluble dietary fiber and mucilage (Singh et al. 2012). Flaxseed mucilage has many applications in the food industry including it is often used as a stabilizer in beverages and is patented as a texturizing ingredient in dairy desserts (Qin et al. 2005).

The need to improve nutritional characteristics in food sector in order to obtain foods that are rich in bioactive molecules, and possess therapeutic potential prompted us to carry out this study, which falls within the scope of developing and optimizing local agricultural resources. The aim is to study the biochemical and pharmacological properties of the *L.usitatissimum*L. seed in order to use it in the manufacture of a dairy dessert.

2. Materials and Methods

Phytochemical and biochemical analyses were carried out to determine various nutritional parameters of the flaxseed powder.

- A phytochemical screening of the flaxseed extract was performed according to standard photochemical screening methods (Kumar et al. 2010).
- Flavonoids content were estimated by applying the method suggested by Bahorun et al. (1996).
- Carotenoids were measured by colorimetry method and quantified using the following equation (Jourdan, 2006).

$$\text{Carotenoids} \quad (\%) = \frac{\text{OD450} \times d}{2.8 \times C}$$

where: OD450: Absorbance at 450 nm, D: dilution, C: concentration of flaxseed powder.

- The mucilage of flax seeds was extracted according to the method described by Dick et al. (2019).
- The flax seeds oil was extracted using the hexane extraction method. The fatty acid profile (Table 1) was determined by gas phase chromatography using CHROMPACK CP 9002. The methyl esters were obtained by esterification with the method put forward by ISO 5509 (ISO, 2000).
- The evaluation of the antioxidant activity of the aqueous extracts and mucilage of flaxseed powder and the prepared dairy desserts was carried out using the DPPH free radical scavenging method (Kim et al. 2002).

Table 1. Fatty acids (%) of flax seed oil.

Fatty Acids	Names	Content (%)
C14:0	Myristic A.	0.05
C16:0	Palmitic A.	5.31
C16:1ω7	Palmitoleic A.	0.05
C18:0	Stearic A.	4.84
C18:1ω9	Oleic A.	20.21
C18:2ω6	Linoleic A.	15.96
C18:3ω3	Linolenic A.	52.69
C20:0	Arachidic A.	0.13
C20:1ω9	Gondoic A.	0.28
	Behenic A.	0.10

Preparation of Dairy Dessert

Five formulations of the dairy dessert were prepared following the standard formulation (F6) according to the dairy desserts production by substituting two ingredients, the milk powder and the gelling agent (carrageenan) by the flaxseed powder according to Table 2.

– The sensory test of the prepared dairy desserts was carried out by a panel of tasters composed of 23 members (both males and females), all of them researchers and teachers at Mouloud Mammeri University of Tizi-Ouzou. The overall sensory quality was assessed by means of a 4- hedonic scale (1–4 points), where 4 was the best score and 1 was the lowest score for color, taste, odor and flavor (Meilgaard et al. 2003).

Table 2. Composition of the different formulations of the dairy desserts prepared.

Formulations	Composition
F 1	F6 without cocoa powder and milk powder, added 50 g of flaxseed powder
F 2	F6 with cocoa powder, 25 g of milk powder substituted by 25 g of flaxseed powder
F 3	F6 with cocoa powder, without milk powder added 50 g of flaxseed powder
F4	F6 with cocoa powder, without milk powder, 1.5% gelling agent substituted by 50 g of flaxseed powder
F 5	F6 with cocoa powder, 25 g of milk powder and 1.5% gelling agent substituted by 25 g of flaxseed powder
F6	1 L of milk, 50 g of milk powder, 130 g of sugar, 20 g of starch, 17 g of cooa powder, 3% de carrageenan, 1.2 g of salt and 1 mL of chocolate flavor.

3. Results and Dicussion

The phytochemical analysis carried out on the aqueous extract of the *Linum usitatissimum* L. showed the presence of different phytochemicals (flavoinoids, free quinones, glucosides, coumarins, alkaloids, mucilage and tannins) and the absence of anthocyanins, saponosides and combined quinone. Our Results are similar to those reported by Alachaher (2018). Analysis of the flaxseed extract revealed flavonoids, glucosides, alkaloids and tannins contents.

Analysis of bioactive substances shows that the aqueous extract of flaxseed has flavonoids with a content of 6.28 mg Quercitin/g of extract. This content is lower than that reported by Bentoumi et al. (2019), which is 7.017 mg Quercitin/g of extract. This difference could be attributed to the different varieties of flaxseeds, the extraction temperature as well as to the technique used. In addition, the richness in phenolic compounds including flavonoids depends on genetic and extrinsic factors, along with climatic conditions, harvest and storage conditions (Amaral et al. 2010). In addition, carotenoids are present in flaxseeds at a level of 4.54 mg/g of extract. These compounds are known for their antioxidant property, i.e., essentially protecting the body against oxidative damage from free radicals.

In terms of mucilage, the *Linum usitatissimum* L. flaxseed has this type of polysaccharide with a yield of 7.08%. This value is lower than that reported by Mazza and Biliaderis, (1989) who found a yield of 9.4%. These authors demonstrated that the mucilage content depends on both extraction temperature and extraction time.

Analysis of the fatty acid profile of flaxseed oil extracted by Soxhlet shows that this seed is rich in unsaturated fatty acids in linolenic acid (52.69%), in linoleic acid (15.96%) and in oleic acid (20.21%). These fatty acids are beneficial for human health; they are said to prevent the onset of many cancers, atheosclerosis and obesity (Kaleem, 2013), and can reduce the risk of cardiovascular disease by lowering the level of triglycerides in the blood.

The evaluation of the antioxidant activity of the aqueous extracts and mucilage of the flaxseed, which was conducted using the DPPH free radical scavenging method, indicated that both extracts showed considerable antioxidant activity at 18.97 ± 4.27% and 12.31 ± 4.96% respectively at the concentration 0.025 g/mL (crude extract). By comparing our results with those of other works carried out on the anti-free radical activity of plant extracts, we have found a correlation between anti-free radical power and the phenolic content compounds. These are recognized as potentially antioxidant substances with the ability to trap radical species (Mansouri et al. 2005, Samaniego Sanchez et al. 2007).

The prepared dairy desserts are rich in flavonoids (Figure 1). These compounds are endowed with pharmacological properties (anti-oxidant and anti-inflammatory). The incorporation of flaxseed in the dessert does not alter the physico-chemical quality of the prepared desserts; a slight decrease in the pH was observed for a partial substitution (quantity of 25 g of flaxseed powder). In general, all the desserts have a quality that complies with the standards of the Official Journal of the Algerian Republic (JORA, 1998). The dessert of formulation F1 composed of 50 g of flaxseed powder and without cocoa powder has a better sensory quality in terms of taste, texture, and color and a higher content of flavonoids (4.06 mg Quercetin/g of Extract) compared to other dairy dessert formulations.

The single-factor ANOVA test shows that the formulation variable has not a significant influence on the taste, smell, color and texture of the prepared dairy desserts made, with a probability of Pr = 1>5%).

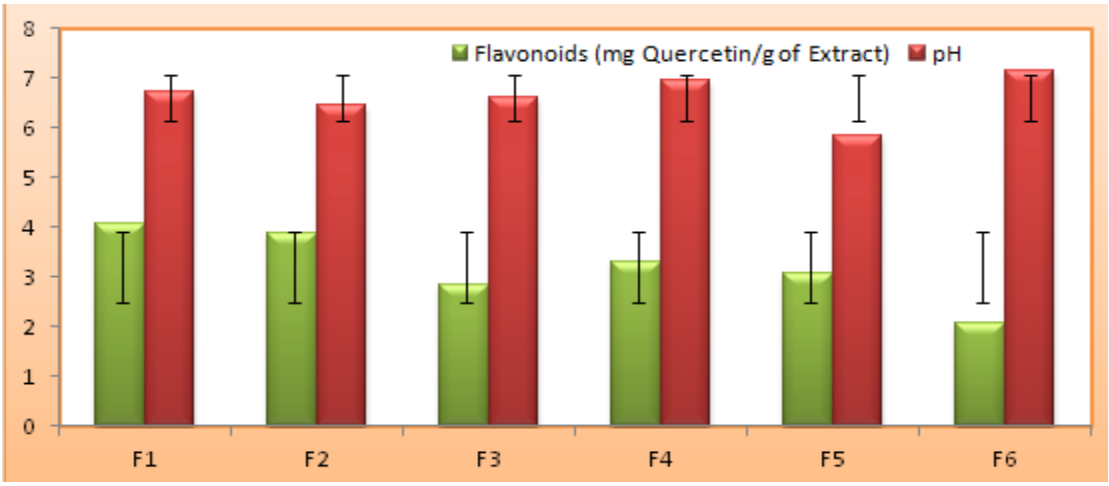

Figure 1. Flavonoids content and pH of the prepared dairy desserts.

4. Conclusions

Flaxseeds are rich in active metabolites, which make them suitable for many industrial applications. The dessert based on flaxseed powder, characterized by nutritional and anti-oxidant properties, could be considered as a new functional healthy dairy product.

Institutional Review Board Statement:

Informed Consent Statement:

Data Availability Statement:

References

1. Amaral, J.S.; Valentao, P.; Andrade, P.B.; Martins, R.C.; Seabra, R.M. Phenolic composition of hazelnut leaves: Influence of cultivar, geographical origin and ripening stage. *Sci. Hortic.* **2010**, *126*, 306–313.
2. Alachaher, F.Z. Effect of Flaxseed Supplementation on Lipid Profile and Redox and Inflammatory Status. Ph.D. Thesis, Ahmed Ben Bella Oran University, Es Senia, Algeria, 2018.
3. Bahorun, T.; Gressier, B.; Trotin, F.; Brunet, C.; Dine, T.; Luyckx, M.; Vasseur, J.; Cazin, M.; Cazin, J.C.; Pinkas, M. Oxygen species scavenging activity of phenolic extract from Hawthorn fresh plant organs and pharmaceutical preparations. *Arzneim-Forsch. Drug. Res.* **1996**, *46*, 1086–1089.
4. Dick, M.; Dal Magro, L.; Rodrigues, R.C.; Rios, A.d.O.; Flores, S.H. Valorization of opuntia monacantha (Willd). Haw. Cladodes to obtain a mucilage with hydrocolloid features physicochemical and functional performance. *Int. J.Biol. Macromol.* **2019**, *130*, 198–205.
5. Kaleem, M. Effects of Products Oxidation of Linoleic Acid on Ruminal Biohydrogenation. Ph.D. Thesis, Toulous University, Toulous, France, 2013.
6. Kim, J.K.; Noh, J.H.; Lee, S.; Choi, J.S.; Suh, H.; Chung, H.Y.; Song, Y.O.; Choi, W.C. The first synthesis of 2, 3, 6-tribromo-4, 5-dihydroxybenzyl methyl ether (TDB) and its antioxidant activity. *Bull. Korean Chem. Soc.* **2002**, *23*, 661–662.
7. Kumar, U.; Kumar, B.; Bhandari, A.; Kumar, Y. Phytochemical investigation and comparison of antimicrobial screening of clove and cardamom. *Int. J. Pharm. Sci. Res.* **2010**, *1*, 138–147.
8. Mansouri, A.; Embarek, G.; Kokkalou, E.; Kefalas, P. Phenolic profile and antioxidant activity of the Algerian ripe date palm fruit (*Phoenix dactylifera*). *Food Chem.* **2005**, *89*, 411–420.
9. Qin, L.; Xu, S.Y.; Zhang, W.B. Effect of enzymatic hydrolysis on the yield of cloudy carrot juice and the effects of hydrocolloids on color and cloud stability during ambient storage. *J. Sci. Food Agric.* **2005**, *85*, 505–512
10. Meilgaard, M.C.; Vance Cicille, G.; Carr, B.T. *Sensory Evaluation Techniques*; CRC Press: Boca Raton, FL, USA; London, UK; New York, NY, USA, 2003; p. 448.
11. Samaniego-Sanchez, C.; Gonzalez, A.M.T.; Garcia-Parrilla, M.C.; Granados, J.J.Q.; Garcia de la Serrana, H.L.; Martinez, M.C.L. Different radical scavenging tests in virgin olive oil and their relation to the total phenol content. *Anal. Chim. Acta* **2007**, *593*, 103–107.
12. Singh, U.; Singh, S.; Kochhar, A. Therapeutic potential of antidiabetic nutraceuticals. *Phytopharmacology* **2012**, *2*, 144–169