

Composition of gum from enzymatic degumming of Water-degummed canola oil

Abstract

The composition of the gum from enzymatic degumming of water-degummed canola oil was determined. Acetone insoluble (AI) and soluble fractions accounted for about 40 and 60% of the gum (dried basis). The AI fraction of the gum (AIED) contained two glycolipid classes, acylated sterol glucosides and sterol glucosides, each of which was present at no more than 1.1%. Five groups of phospholipid and lysophospholipid, phosphatidylethanolamine, lyso-phosphatidylethanolamine+lyso-phosphatidic acid, phosphatidylinositol+ phosphatidic acid+lyso-phosphatidylinositol, phosphatidylcholine and lyso-phosphatidylcholine, appeared at less than 4% each in AIED. In total, all the lipids detected accounted for about 12% of AIED. The information provided in this study is useful for evaluating the potential of the gum, a by-product of the enzymatic degumming, for value-added product development.

Keywords: enzymatic degumming, gum, phospholipid, lysophospholipid, glycolipid

Volume 3 Issue 1 - 2016

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Received: August 27, 2016 | **Published:** September 09, 2016

Introduction

Enzymatic degumming which utilizes enzymes to hydrolyze phospholipid during degumming of vegetable oil was developed in the 1990s. It was initially designed to remove non-hydratable phospholipid, and produce degummed oil suitable for physical refining. Later on, enzymatic degumming was found to increase oil yield, reduce the amount of harsh chemicals required and decrease the amount of waste water and gum produced.¹⁻³ Recently, it was reported that the gum obtained from enzymatic degumming of crude canola oil with phospholipase A₁ could be used to produce value-added products enriched in lyso-phosphatidylcholine,⁴ a class of amphiphilic lipid possessing excellent oil-in-water emulsifying properties and health benefits. To the best of our knowledge, water-degummed vegetable oils are utilized for the commercial enzymatic degumming processes.⁵ However, little information is available on the gum produced during this process. The objective of this study was to investigate the composition of gum from enzymatic degumming of water-degummed vegetable oil, and provide useful information for evaluating the gum for value-added products development.

Materials and methods

Materials

Crude canola oil was provided by ADM (Decatur, IL). Phospholipase A₁ (Lecitase Ultra) was donated by Novozymes (Bagsvaerd, Denmark). Glycolipid standards were purchased from Matreya (Pleasant Gap, PA). Phospholipid and lysophospholipid standards were purchased from Avanti (Alabaster, Alabama).

Degumming of water-degummed canola oil

Crude canola oil was first degummed with water at 80°C for 1 hour, and the resulting water-degummed canola oil had a phosphorus content of 76.73mg/kg. Enzymatic degumming of the water-degummed canola oil was performed according to the procedure reported by Xie et al.⁴ Briefly, the enzymatic reaction was performed at 50°C for 6h. A

control degumming experiment was carried out without the addition of the enzyme.

Composition analysis

The wet gum samples were dried at 105°C in a forced air oven (VWR Science Model 1370 FM, Bristol, CT), the yield of dried gum was calculated. The acetone insoluble (AI) and soluble (AS) contents of the wet gum were determined according to the AOCS official method Ja 4-46.⁶ The AI fraction was then analyzed for phospholipid and glycolipid composition using HPLC-ELSD. The detailed procedure was described in a previous study.⁴

Statistical analysis

All experiments and analytical tests were carried out in duplicate. Statistical software SAS version 9.3 (SAS Institute Inc., Cary, NC, USA) was used for data analysis.

Results and discussion

Enzymatic degumming of the water-degummed oil led to a residual phosphorus content in the final oil much lower than the control process (Table 1). The amount of dried gum produced from the enzymatic degumming process was 0.79%, which was significantly ($P<0.05$) lower than that from the control degumming process (1.05%). Generally, the components of the gum from degumming of vegetable oil can be divided into two fractions based on their solubility in acetone. The acetone soluble (AS) fraction contains components with low polarity such as triacylglyceride, free fatty acid, sterol and so on; while the acetone insoluble (AI) fraction mainly contains polar lipids such as phospholipid, lysophospholipid and glycolipid,⁷ which possess valuable properties for applications in food and other industries. In this study, AI and AS fractions accounted for about 40 and 60% of the gum from the enzymatic degumming process, respectively. The control degumming process resulted in a gum with about 11% of AI and 89% of AS.

Of the five glycolipid classes examined, acylated sterol glucosides, sterol glucosides, cerebrosides, monogalactosyl diglycerides and digalactosyl diglycerides, only acylated sterol glucosides and sterol glucosides were detected in AI fractions of the gum samples collected (Table 2). The amounts of acylated sterol glucosides (1.1%) and sterol glucosides (0.57%) in the AI fraction of gum from enzymatic degumming (AIED) were significantly ($P<0.05$) higher than that in the AI fraction of gum from the control degumming process (AICD). As a result, AIED had a higher content of total glycolipid than AICD. Three groups of phospholipid and lysophospholipid classes, phosphatidylethanolamine, phosphatidylinositol+phosphatidic acid+lyso-phosphatidylinositol, and phosphatidylcholine, were identified in both AICD and AIED (Table 2). The amounts of phosphatidylethanolamine, phosphatidylinositol+acid+lyso-phosphatidylinositol and phosphatidylcholine in AIED were significantly lower than that in AICD. Two groups of lysophospholipid, lyso-phosphatidylethanolamine+lyso-phosphatidic acid and lyso-

phosphatidylcholine, which were not detected in AICD, were found in AIED. The dramatic difference in the amounts of the phospholipid and lysophospholipid groups between AICD and AIED was due to the conversion of phospholipid into lysophospholipid by the enzyme used. All the five groups of phospholipid and lysophospholipid were present at less than 4% each in AIED, and in total accounted for 10.4% of AIED. The total phospholipid+lysophospholipid content of AICD was 17.91%, which was significantly higher than that of AIED. Again, this was due to the conversion of phospholipid into lysophospholipid which have smaller mass (molecular weight), resulting in the reduced weight percentage of total phospholipid+lysophospholipid in AIED. The total lipids analyzed in this study accounted for about 12% of AIED and 19% of AICD. More than 80% of AIED and AICD were unidentified impurities. Citric acid and its sodium salt, which was introduced and formed during the degumming processes, may constitute a significant portion of the impurities in these AIs.

Table 1 Results of enzymatic degumming and the control processes

Process	Control	Enzymatic degumming
Residual phosphorus of degummed oil (mg/kg)	32.27 ± 0.26 ^a	5.46 ± 0.08 ^b
Yield of dried gum (wt% of water-degummed oil)	1.05 ± 0.04 ^a	0.79 ± 0.03 ^b
AI	11.26 ± 0.34 ^b	39.85 ± 0.23 ^a
Composition of gum (wt%, dry basis)	AS	88.52 ± 0.34 ^a
		59.83 ± 0.11 ^b

AI, acetone insoluble; AS, acetone soluble

Values are Means±SEM. Means in the same row with the same letter are not significantly different from each other ($P>0.05$).

Table 2 Lipid composition of acetone insoluble (AI) fraction of gums from enzymatic degumming and the control processes (wt%, as it is)

Lipid	AICD (wt% as it is)	AIED
Acylated sterol glucosides	0.40 ± 0.01 ^b	1.10 ± 0.02 ^a
Sterol glucosides	0.30 ± 0.01 ^b	0.57 ± 0.02 ^a
Cerebrosides	n.d	n.d
Monogalactosyl diglycerides	n.d	n.d
Digalactosyl diglycerides	n.d	n.d
Total glycolipid	0.70 ± 0.01 ^b	1.67 ± 0.03 ^a
Phosphatidylethanolamine	5.63 ± 0.06 ^a	0.60 ± 0.01 ^b
Lyso-phosphatidylethanolamine +lyso-phosphatidic acid	n.d	3.90 ± 0.06
Phosphatidylinositol + phosphatidic acid +lyso-phosphatidylinositol	8.04 ± 0.07 ^a	3.20 ± 0.04 ^b
Phosphatidylcholine	4.24 ± 0.06 ^a	0.98 ± 0.01 ^b
Lyso-phosphatidylcholine	n.d	1.72 ± 0.02
Total phospholipid +lysophospholipid	17.91 ± 0.10 ^a	10.40 ± 0.06 ^b
Total	19.09 ± 0.13 ^a	12.29 ± 0.09 ^b

AICD, acetone soluble fraction of gum from the control degumming process; AIED, acetone soluble fraction of gum from enzymatic degumming
Values are Means±SEM. Means in the same row with the same letter are not significantly different from each other ($P>0.05$).

n.d: not detected.

Conclusion

The data presented in this study not only enriches the knowledge on the gum from enzymatic degumming of water-degummed vegetable oil, it also provides useful information for evaluating the gum for development of value-added products.

Acknowledgements

None.

Conflict of interest

The author declares no conflict of interest.

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