

Effects of Press Speed, Restriction Die Size, and Moisture Content on Safflower Oil Yield and Process Optimization

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ABSTRACT

Safflower oil is conventionally produced through solvent extraction or mechanical pressing. Despite low recovery rate, expeller-pressed oil tends to better preserve bioactive components from oilseeds due to its gentle processing and elimination of harsh refining steps. The research objective was to investigate effect of various pressing parameters including press speed, restriction die size, and seed moisture on the yield of high gamma-linolenic acid safflower oil. The study showed that press speed and die size exerted significant influences on oil yield while moisture content effect was insignificant.

INTRODUCTION

Expeller-pressing of seed oil has seen revived interest recently because it eliminates usage of hazardous solvent in oil extraction. Though safflower seeds have been processed through expeller-pressing in industry for decades, there were no literature reviews on how pressing parameters could affect safflower oil yield. The study findings would be valuable in developing initiatives to overcome issues of low extraction efficiency in safflower oil processing.

OBJECTIVES

The research purpose was to investigate influence of various pressing parameters including press speed, restriction die size, and seed moisture on safflower oil yield and to optimize safflower oil production procedure using a pilot-size press.

MATERIALS

High gamma-linolenic acid safflower seeds were supplied by the Arcadia Bioscience (Davis, CA). Seeds were stored at -20°C until pressing. Comet Press CA95G (IBG Monforts Oekotec GmbH & Co., Germany), which was capable of processing 3 to 5 kg of seed per hour, was used in the pressing study.



METHODS

Effect of press speed on safflower seed oil yield was studied by pressing safflower seeds at 35, 63, 89, and 117rpm, which corresponded to speed no. 2, 4, 6, and 8 on the expeller press with a 6mm-restriction die installed. Pressure influence on oil yield was investigated by varying restriction die sizes at 6, 8, and 10 mm. In these set of studies, press speed was maintained at 35rpm for the longest residence time and seeds at 6% moisture content (d.b.) were used. Seeds were dried/rehydrated to 4, 6, 8, and 10% total moisture content (d.b.) for assessing moisture effects on oil yield

Before each test, the expeller press was preheated to 60°C to warm up the machine. Oil collected from the press was centrifuged at 10000 rpm at 4°C for 10 minutes to remove fine particles. All runs were performed in triplicate. Oil yield was calculated as below.

Oil Yield (%) = Weight of Filtered Oil/ Dry Weight of Seed x 100%

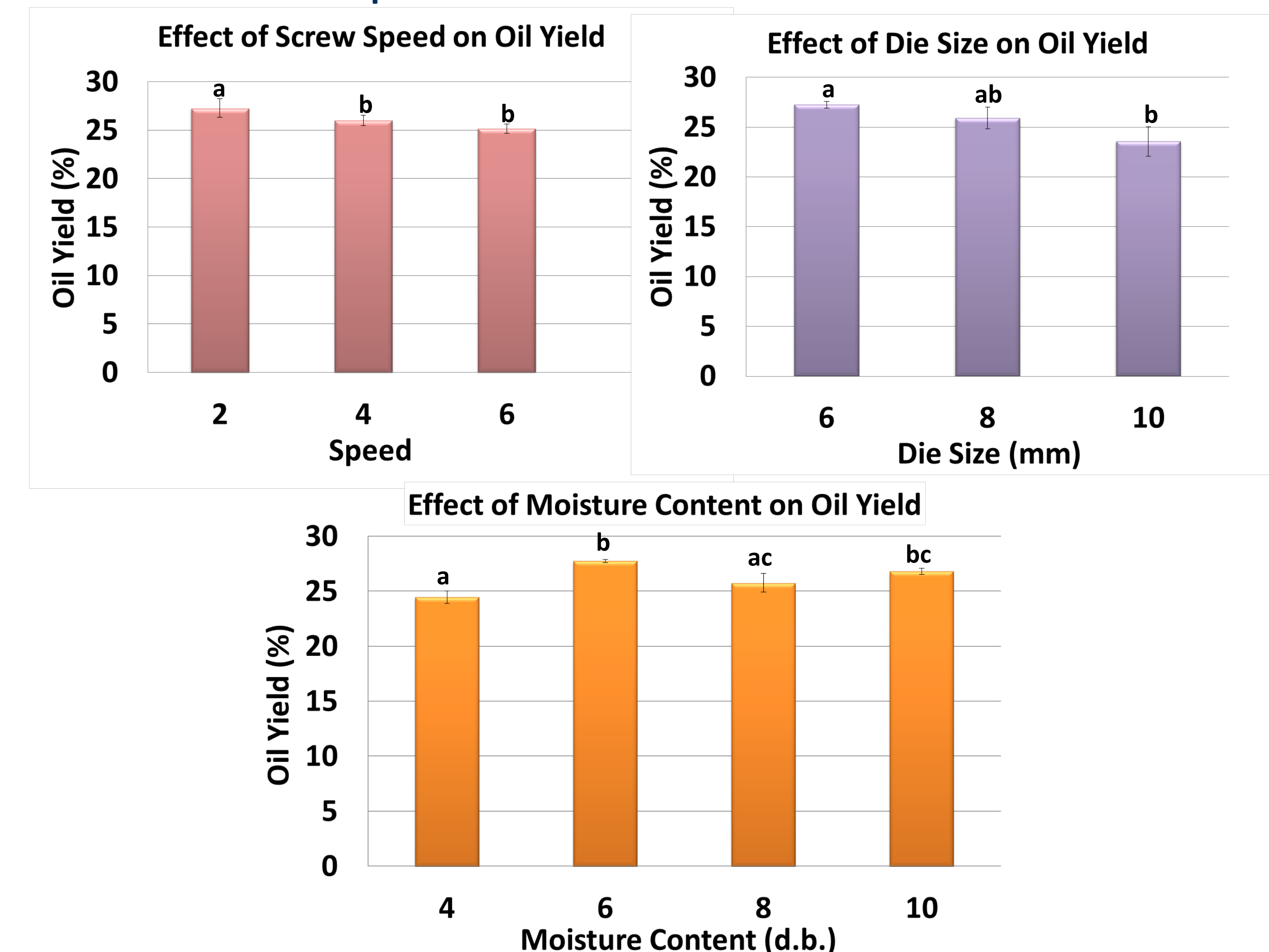
Press conditions for safflower oil pressing were optimized through response surface methodology using a central composite face-centered design as shown in Table 1.

Table 1. Central Composite Design for Oil Yield Optimization

Run	Moisture content (%d.b.)	Speed	Die Diameter (mm)
1	8	8	10
2	8	8	6
3	8	2	10
4	8	2	6
5	4	8	10
6	4	8	6
7	4	2	10
8	4	2	6
9	8	5	8
10	4	5	8
11	6	8	8
12	6	2	8
13	6	5	10
14	6	5	6
15-20	6	5	8

RESULTS AND DISCUSSIONS

Results showed that as screw speed increased, oil yield decreased from 27.26±0.33% to 25.14±0.39%. Blockage occurred when speed 8 was used, resulting in no oil produced. Oil yield reduced from 27.26±0.33% to 23.57±1.47% when die opening was increased from 6 to 10mm. This was attributed to reduced internal pressure in the press. In moisture content study, oil yield peaked at 27.76±0.13% when seeds with 6% moisture were pressed.



Based on the response surface analysis, the effect of press speed, die diameter, and moisture content on oil yield can be represented by the following model,

$$Y = 13.60 - 4.46S - 4.18D + 8.07S^2 - 6.97D^2$$

where Y = oil yield, S = speed, D = die size.

However, an optimum point was not successfully identified.

CONCLUSIONS

Both press speed and die size showed significant influence on oil yield for safflower seed pressing while the moisture content effect was not significant. Further study is required to determine the optimum conditions for obtaining maximum oil yield.

