Effect of centrifugation on temperature of sesame paste

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Abstract: The sesame seeds were mechanically cold pressed at temperature below 45℃ then centrifuged. No chemicals were used. The temperature during centrifugation of sesame paste was recorded. Temperatures in less than one hour elevated to 148, 273 and 315℃ in 1,200, 1,800 and 2,400 G-force centrifugal acceleration, respectively. Since the centrifugal accelerations during processing will be cut to 1200 G-force in about 35 min, 1800 G-force in 20 min and 2400 G-force with the time 10 min, the maximums temperatures raised about 100℃. Linear and quadratics regression model were fitted to data.

Keywords: cold pressed oil, centrifugation, sesame paste, temperature

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1 Introduction

Sesame (Sesamum indicum L) is grown mainly for its oil-rich seeds that come in a variety of colors from cream-white to charcoal-black. The colorless varieties of sesame seem to be more valued in the West and Middle East, while the black varieties are highly valued in the Far East. The small sesame seed is used in cooking for its rich nutty flavor (although such heating damages their healthful and polyunsaturated fats) and yields sesame oil (Abu-Jdayil, Al-Malah and Asoud, 2002).

The sesame seeds are protected by a capsule, which does not burst open until the seeds are ripe. The ripening time tends to vary. For this reason, the farmers cut plants by hand and place them together in upright position to carry on ripening for a few days. The seeds are only shaken out onto a cloth after all the capsules have opened (Seed, Tunde-Akintunde and Akintunde, 2004).

In many places around the world, there are maintained traditional methods that produce high quality nutrient rich unrefined oil that have incredibly delicious flavor. A central part of the Middle-Eastern diet for centuries, the sesame seed has been used for cooking and beauty body care. The oil that is pressed from this small seed is rich and golden in color with a delicious nutty taste. For most people in North America two foods come to mind when one thinks of sesame: HALVAH, the middle eastern sweet and TAHINI, the sesame butter paste that is used in such dishes as BABA GANOUJ(made with eggplant) and HUMMOUS (made with chick peas). Many followers of the macrobiotic lifestyle use sesame oil for stir-frying vegetables in a wok, and for Japanese-style salads (Razavi et al., 2007).

Sesame seed is a rich source of oil (44%) and protein (19%–25%). Sesame seed oil is used as a cooking oil and raw material for producing some industrial materials including paints, margarine and varnishes. Its protein has a high desirable amino-acid profile and is nutritionally as good as Soya bean protein (Arslan, Yener and Esin, 2005). The usual method of sesame seed oil extraction at the domestic level is by pounding the seeds in a mortar. Hot water is then poured into the mortar causing the oil to float to the surface, from where it is skimmed off. This method is however slow, labor intensive and results in low yields of oil (Majdi et al., 2007).

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Sesame Seed Oil is produced in the most natural way possible, neither chemicals or additives are used. The finest of sesame seeds are mechanically cold pressed at a temperature below 45℃ then filtered, producing the best in Sesame oil there is on the market today for all your culinary needs. No chemicals are used to extract this Oil. This oil is non-toasted, thus avoiding any nutrients escaping in the toasting process (Kahyaoglu and Kaya, 2006). The pulp remaining from the cold pressed process is reprocessed at a temperature above 100℃ to extract more oil. The higher temperature causes the oil to have a darker color and a strong flavor (Deniz et al., 2008).

There are published works about the properties of sesame (Mohammad, Najafi and Alaei, 2006), Sesame Paste Blends (Alpaslan and Hayta, 2002; Arslan, Yener and Esin, 2005), and Tahineh (Abu-Jdayil, Al-Malah and Asoud, 2002). After much searching, the thermal behavior of oily nut pastes during centrifugation was not found. There is no information about sesame temperatures while centrifuged. The aim of this study was to investigate the effect of centrifugal action on temperature of sesame during oil extraction.

2 Materials and methods

2.1 Extraction by cold pressing

Mechanical screw presses (oil expellers) are commonly used for extraction of oil from various oil seeds, nuts, and beans and so on either for full press or for pre-press. Small and medium capacity oil mill plants use full press extraction screw presses/expellers while large capacity plants use pre press extraction with solvent extraction process.

Presses range from small, hand-driven models that an individual can build to power-driven commercial presses. The ram press uses a piston inside a cage to crush the seed and force out the oil (Herz, 1997).

Expellers have a rotating screw inside a horizontal cylinder that is capped at one end. The screw forces the seeds or nuts through the cylinder with gradually rising pressure. Friction and electric heaters or a combination of the two heats the seed (Willems, Kuipers and Haan, 2008). Once the cap is removed, oil escapes from the cylinder through small holes or slots and the press cake, or meal, emerges from the end of the cylinder. The pressure and temperature can be adjusted for different kinds of feedstock.

One cylinder press that expels the press cake out in pellet form and a traditional cage-style screw press that expels the meal out in large flakes (Figure 1). The machines operate on a gentle mechanical press principle that does not involve mixing and tearing the seeds. Nearly most oil-bearing seeds, nuts and kernels can be pressed with standard equipment and without adjusting the screws or oil outlet holes (Figure 2). After oil expelling, the sesame paste was discharged form expeller and the pastes were usually consumed as livestock feed. Expeller processing can not remove every last trace of liquid (usually oil) from the material. A significant amount

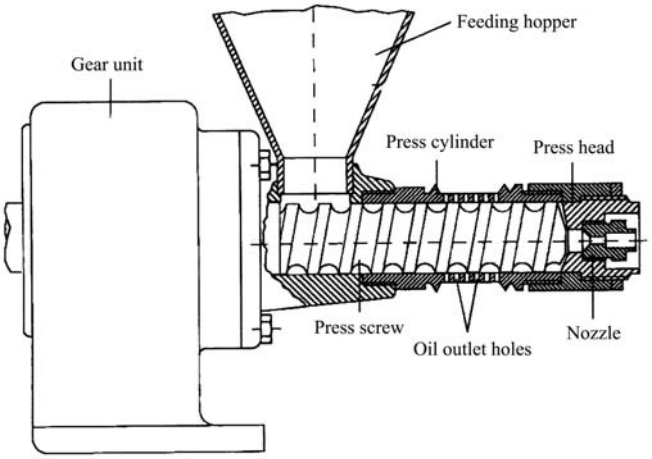

Figure 1 Sectional view of single cylinder oil expeller

Figure 2 One-ton press oil expeller (Anyang GEMCO China)

remains trapped inside the cake leftover after pressing. In most small-scale rural situations, this is of little or no importance as the cake that remains after the oil has been removed finds usage in local dishes, in the manufacture of secondary products or for animal feed. Some raw materials however do not release oil by simple expelling; the most notable being rice bran. To remove oil from commodities that do not respond to expelling or to extract the final traces of oil after expelling it is needed to use solvent extraction (Döker et al., 2010).

Sesame oil was extracted using mechanically ram press, an expeller or even a wooden mortar and pestle, a traditional method that originated in Iran.

2.2 Extraction by centrifuge action

The centrifuge machine made by Heinkel Filtering Systems, Inc. USA was used for next process. Beaker centrifuge contains two beakers with maximum volume of 1.18 L each to filter and separate (Figure 3). Unit is gas tight and totally enclosed. Variable frequency drive allows high G-forces to be gained.

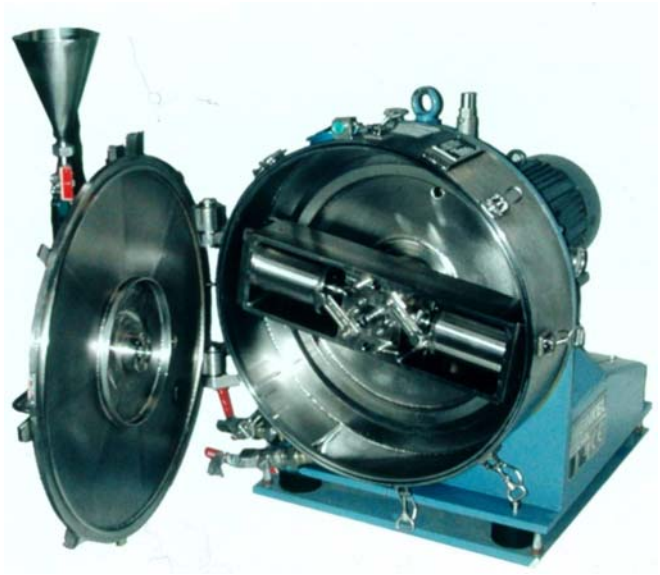

Figure 3 Two-beaker centrifuge machine (Heinkel Filtering Systems, Inc. USA)

Commercial sesame samples were got from local market, Qom, Iran. Preparation of the seeds includes removing husks or seed coats from the seeds and separating the seeds from the chaff and drying. The average density of sesame seed was 1224 kg/m^3 at moisture content 3.4% (w.b.). About 3 kg of sesame was used for expelling oil for first step in one-ton press oil expeller (Anyang GEMCO China), after pressing in expeller; the sesames paste was placed into centrifuge to separate the oil in secondary step. All tests were repeated three times.

The centrifuge tests were down in rotation speeds: 3,000, 4,500 and 6,000 r/min that equal to 1,200, 1,800 and 2,400 G-force centrifugal accelerations (where g is the unit of acceleration equals to 9.81 m/s^2) for 1 h. After every 5 min, the rotor was stopped, opened the centrifugal lid and measured the temperature of sesame paste. Using a thermometer LUTRON TM-915 two-channel thermometer and a resolution of 1℃ with 20 cm (type K) prop.

3 Results and discussion

The average results from three tests were shown in Table 1 and Figure 4. As is shown in Figure 4, the mean temperature of sesame paste in three reproduce when arrived in centrifuge machine have 43, 39 and 40℃, but during centrifugation in less than 1 h raised to 148, 273 and 315℃ in 3,000, 4,500 and 6,000 r/min, respectively. Linear and quadratics regression model were fitted to data as Equations (1), (2) and (3):

$$\theta = 34.3 + 1.982T \quad R^2 = 0.986$$
$$3000rpm(1200G - force) \tag{1}$$

$$\theta = 46.64 + 1.461T + 0.04184T^2 \quad R^2 = 0.989$$
$$4500rpm(1800G - force) \tag{2}$$

$$\theta = 48.36 + 5.047T + 0.01021T^2 \quad R^2 = 0.997$$
$$6000rpm(2400G - force) \tag{3}$$

where, T is the time in min and θ is temperature in ℃.

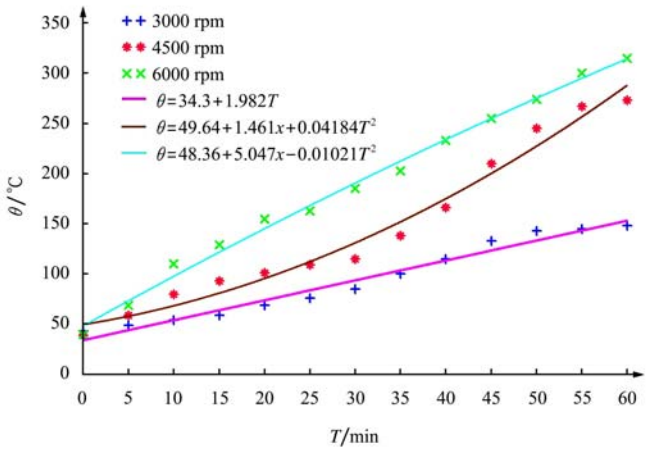

Figure 4 Sesame paste temperature vs. time in centrifuge

Table 1 Average temperature of sesame paste at different rotation speeds

Time /min	Temperature/℃		
	3000 (r/min)	4500 (r/min)	6000 (r/min)
0	43	39	40
5	49	59	69
10	54	80	110
15	59	93	129
20	69	101	155
25	76	109	163
30	85	115	185
35	100	138	203
40	115	166	233
45	133	210	255
50	143	245	274
55	145	267	300
60	148	273	315

4 Conclusions

The data presented here confirm the rising temperature of sesame paste during the centrifugation for expelling oil and investigates basis for further. The specific aims of this study were to provide preliminary data about rising temperature of the sesame pulp during centrifugation to protection from overheating and not to explain the effect of temperature or speed of the centrifuge (r/min) on the oil content those release from the pulp.

Oil expellers are full press extraction screw presses are used by small and medium capacity oil mill plants while pre press extraction with solvent extraction process is used by large capacity plants. In comparison with these methods, centrifugation has a “good” secondary step of the sesame oil expelling with no need for special solvent. The results show that centrifugation represents a workable option for cold-pressed sesame oil, since the centrifugal accelerations during processing will be lowered to 1200 G-force in about 35 min, 1800 G-force in 20 min and 2400 G-force with the time 10 min, the maximums temperatures raised about 100℃.

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