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Effect of Centrifugation on Sesame Paste Temperature

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Abstract: The sesame seeds were mechanically cold pressed at temperature below 45°C then centrifuged. No chemicals were used. The temperature during centrifugation of sesame paste was recorded. Temperatures in less than one hour operation has elevated to 148, 273 and 315°C in 1200, 1800 and 2400 G-force centrifugal acceleration, respectively. Since the centrifugal accelerations during the process cut at 1200, 1800 and 2400 G-force at about 35, 20 and 10 minutes, respectively. The maximum allowable temperatures raised to about 100°C. Linear and quadratics regression model were fitted to data.

Key words: Cold pressed oil; Centrifugation; Sesame paste; Temperature effect

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 regions, 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 [1].

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 [2].

In many places around the world, they have maintained traditional methods that produce high quality nutrient rich unrefined oils 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 [3].

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 food products and other industrial applications including paints, margarine and varnishes. Its protein has a high desirable amino-acid profile and is nutritionally as good as Soya bean protein [4]. 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 [5].

Sesame seed oil is produced in most natural way possible, no chemicals or additives are used. The finest of sesame seeds are mechanically cold pressed at a temperature below 45°C then filtered, producing the best in sesame oil product. Today, the sesame oil product is available in market for all your culinary needs. No chemicals are used to extract the sesame oil. This oil is non-toasted, thus avoiding any nutrients escaping in the toasting process [6].

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The pulp remaining from the cold pressed process is reprocessed at a temperature above 100°C to extract more oil. The higher temperature causes the oil to have a darker color and a strong flavor [7].

There are published data available as literature about the properties of sesame [8]. The products are Sesame Paste Blends [4, 9] and Tahineh [1]. However additional searching conducted about the thermal behavior of oily nut pastes during centrifugation; there was no data found in this regard. There is no information about sesame temperatures while centrifuged. The aim of present work was to investigate the effect of centrifugal action on sesame temperature during oil extraction.

MATERIALS AND METHODS

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 [10].

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 [11]. Once the cap is removed, the 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 cannot remove every last trace of liquid (usually oil) from the material. A significant amount remains trapped inside the cake leftover after pressing.

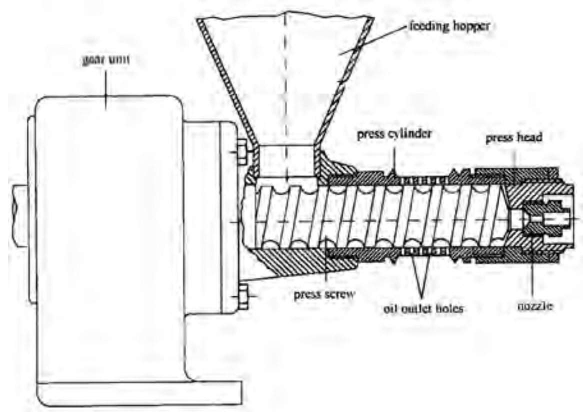

Fig. 1: Sectional view of single cylinder oil expeller

Fig. 2: The one-ton press oil expeller (Anyang GEMCO China)

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

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 uses 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 [12].

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

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

Commercial sesame samples were available 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 1224kg/m^3 at moisture content of 3.4% (w.b.). About 3 kg of sesame was used for expelling oil in 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 carried out in rotation speeds: 3000, 4500 and 6000 rpm that equal to 1200, 1800 and 2400 G-force centrifugal accelerations (where g is the unit of acceleration equals to 9.81m/s^2) for one hour. After every 5 minutes, 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°C with 20 cm (type K) prop.

RESULTS

The average results from three tests are shown in Table 1 and Figure 4. As shown in the figure, the mean temperature of sesame paste in three reproduce when arrived in centrifuge machine have 43, 39 and 40°C, but during centrifugation in less than one hour raised to 148,

Table 1: The average temperature of sesame paste at 3000, 4500 and 6000 rpm

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

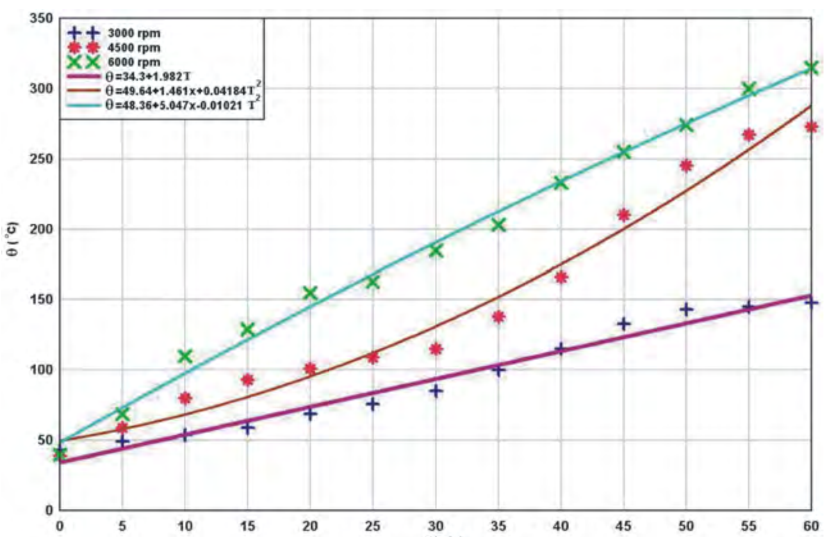

Fig. 4: Sesame paste temperature vs. time in centrifuge

273 and 315°C in 3000, 4500 and 6000 rpm, respectively. Linear and quadratics regression model were fitted to data as equations 1, 2 and 3:

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

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

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

where T is the time in minute and θ is temperature in °C.

CONCLUSION

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 protect from overheating and not to explain the effect of temperature / speed of the centrifuge (rpm) on the oil content released 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 extraction. The results showed that centrifugation represents a workable option for cold-pressed sesame oil, since the centrifugal accelerations during the oil extraction process has lowered the extraction time to about 35, 20 and 10 minutes for 1200, 1800 and 2400 G-force, respectively. The maximums sesame paste temperature was about 100°C.

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