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Research article

Heat Retention Properties of Male and Female Salt in Thai Traditional Medicine

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Abstract: The salt pot compress method in postpartum women involves putting male salt in a clay pot, known as a cooking pot, for heat retention. According to Thai traditional medicine textbooks, there are two types for the nature of salt: male and female. Nonetheless, no report has specified why it needs to be only the male salt and whether it must be sea or rock salt. Some textbooks have not explicitly stated that it must be the male salt. Thus, the objectives of this study are as follows: 1) To determine the heat retention properties of both male and female sea salt; 2) To compare the heat retention properties of both male and female sea salt. The results showed that the size and volume of both types of salt decreased after heating. Meanwhile, higher temperature and a longer time in the pot enhanced the salt's heat. However, the heat retention time of those types of salt decreased with increasing experimental cycles. Moreover, the male sea salt maintained better heat retention properties than the female sea salt. Thai traditional medicine practitioners suggest using male sea salt as an intervention for the salt pot compress method. If male sea salt is not found, large grains of salt will work in its place. The heated salt can also be reused due to no loss in its heat retention properties for up to 2-3 uses. Nevertheless, increasing the time and energy required to heat the salt depends on the number of cycles.

Keywords: Salt; sea salt; male sea salt; female sea salt.

1. Introduction

Thai traditional medicine has played an important role in the lives of Thai people for ages, usually in the forms of medical treatment, pharmaceuticals, and massage, including midwifery. [1-3] The rehabilitation of postpartum women, or "Yoo-Fire," comprises several steps. [4-5] One of them is the salt pot compress method [6], which uses the heat from the salt pot to help improve the blood and lymphatic circulation system. [7-11]

Textbooks and research studies on the salt pot compress method in postpartum women state that male salt can retain heat better. [12-13] According to Thai traditional medicine textbooks, there are two types of natural salt: male and female. Nonetheless, no reports identify why it has to be only the male salt. Besides, some texts do not specify the use of male salt. They only state that salt or salt grains are used for heat retention in the clay pot. For these reasons, the researcher is interested in building further knowledge on the salt pot compress method, including salt types and heat retention properties. Moreover, the heat retention properties of the male and female salts in this study are also compared.

2. Materials and Methods

Part 1: Measure the size and weight of the clay pot

Prepare the clay pots with a similar size of about 7 centimeters in diameter according to the standard size for the salt pot compress method. Measure the diameter at the bottom and the mouth (both inside and outside), including around the neck, the bottom of the widest part, the depth, the thickness, and the weight of the pot.

Part 2: Measure the size (volume) and weight of salt grains

Randomly select 10 male and female sea salt grains in the pot. Measure the size of salt grains using a Digital Vernier Caliper for each salt grain's width, length, and thickness. Then, weigh and calculate the mean value.

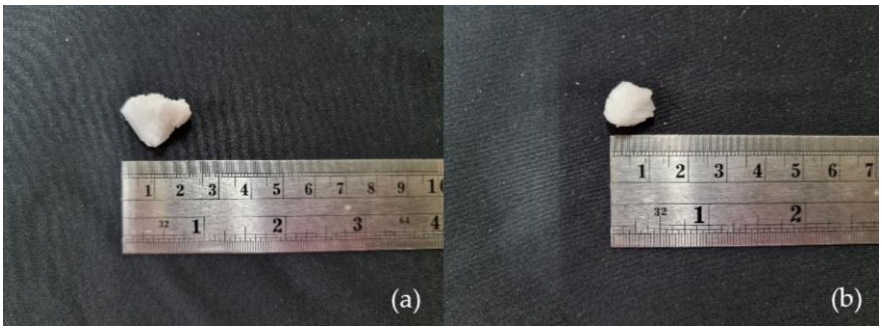

Figure 1. (a) Male sea salt, (b) Female sea salt

Part 3: The Experimental Process

1. Put the male and female salt into 3 clay pots for each type of salt, with the salt density in each pot of 0.8 g/cm^3. Then, calculate by using the formula D=m/v, where D = the density of salt, m = the mass of salt (grams), and v = the volume of the clay pot (cubic cm). The volume of the clay pot is obtained by putting water into the pot and pouring the water into a measuring cylinder to find the volume.

Figure 2. Preparation salt in pot (Mor-ta-non)

2. Set the timer to 5 minutes after setting the electric stove to 300 degrees Celsius. Then, put the pot of salt on the electric stove. Observe the timer until the salt is heated. Record the temperature and the length of time that the salt took to be heated on the form.

Figure 3. Heating the salt pot

3. Lift the pot out to place onto the Spider lily leaves with the roughly pounded fresh herbs at the bottom. The fresh herbs include. *Curcuma xanthorrhiza* Roxb, *Curcuma aromatica* Salisb, *Curcuma aeruginosa* Roxb, *Zingiber cassumunar* Roxb, and *Cinnamomum camphora* (L.) J. Presl, Equal [14-17], wrapped in the calico cloth for the prepared salt pot compress method. Then, record the salt temperature in the clay pot by wrapping it with the calico cloth until it has dropped to room temperature (34 degrees Celsius). Next, reheat the salt pot. Repeat this step for 5 rounds and record the results on the form.

Figure 4. (a) Herbal preparations, (b) Wrapping the Pot, (c) Measuring the temperature inside and outside the pot

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Subject: Notification of research project outcomes for consideration. According to the paper, the Human Research Ethics Subcommittee of the Rajamangala University of Technology, Isan Sakon Nakhon Campus, has reviewed the above research project documents. It was determined that "this research does not qualify as human research." As a result, it is not considered human subjects research and does not require ethical review by the Human Research Ethics Subcommittee.

3. Results and Discussion

The heat-retaining properties of male and female sea salt

Part 1: Information about the pots (Mor-ta-non)

Table 1. Size and weight information for male sea salt pots (Mor-ta-non)

Data of pots (Mor-ta-non)	Pot 1	Pot 2	Pot 3	average
Pot depth (cm)	8.50	8.50	8.50	8.50 ± 0.00
External pot mouth diameter (cm)	10.20	10.70	10.60	10.50 ± 0.26
Internal pot mouth diameter (cm)	7.00	7.50	7.40	7.30 ± 0.26
Around the neck of the pot (cm)	29.00	31.70	29.20	29.97 ± 1.50
Around the bottom of the pot (cm)	37.20	37.80	37.30	37.43 ± 0.32
Pot bottom diameter (cm)	11.70	11.90	11.80	11.80 ± 0.10
The thickness of the pot (cm)	0.70	0.70	0.70	0.70 ± 0.00
Pot weight (g)	350.00	350.00	340.00	346.67 ± 5.77

The pots of male sea salt had the sizes above for depth, outer and inner diameter of pot mouth, around the pot neck and bottom, and thickness. The mean values were 8.50 ± 0.00, 10.50 ± 0.26, 7.30 ± 0.26, 29.97 ± 1.50, 37.43 ± 0.32, 11.80 ± 0.10, and 0.70 ± 0.00 centimeters, respectively. The mean weight of the clay pots was 346.67 ± 5.77 grams (Table 1).

Table 2. Size and Weight of Female Sea Salt Pots (Mor-ta-non)

Data of pots (Mor-ta-non)	Pot 1	Pot 2	Pot 3	average
Pot depth (cm)	8.70	8.50	8.50	8.57 ± 0.12
External pot mouth diameter (cm)	10.20	10.20	10.70	10.37 ± 0.29
Internal pot mouth diameter (cm)	7.20	7.00	7.50	7.23 ± 0.25
Around the neck of the pot (cm)	29.50	29.00	31.70	30.07 ± 1.44
Around the bottom of the pot (cm)	37.00	37.20	37.80	37.33 ± 0.42
Pot bottom diameter (cm)	11.70	11.70	11.90	11.77 ± 0.12
Thickness of the pot (cm)	0.70	0.70	0.70	0.70 ± 0.00
Pot weight (g)	350.00	350.00	350.00	350.0 ± 0.00

The pots of female sea salt had the sizes mentioned above for depth, the outer and inner diameter of the pot mouth, around the pot neck and bottom, the diameter of the pot bottom, and thickness. The mean values were 8.57 ± 0.12, 10.37 ± 0.29, 7.23 ± 0.25, 30.07 ± 1.44, 37.33 ± 0.42, 11.77 ± 0.12, and 0.70 ± 0.00 centimeters, respectively. The mean weight of the clay pot was 350.0 ± 0.00 grams (Table 2).

Part 2: Data of male and female sea salt grains before and after the experiment

Before and after the experiment on heat retention of male and female sea salt, this study randomly selected the salt from the experimental pots to measure size and weight as follows:

Table 3. Volume and weight of male sea salt before and after the experiment.

	Pot 1	Pot 2	Pot 3	average
summary volume of salt grains				
Before the experiment (cm^3)	2.47	2.51	2.50	2.49 ± 0.02[a]
After the experiment (cm^3)	2.18	2.24	2.16	2.19 ± 0.04[b]
Weight of salt grains				
Before the experiment (g)	1.49	1.49	1.44	1.47 ± 0.03[a]
After the experiment (g)	1.23	1.17	1.25	1.22 ± 0.04[b]

Annotation: Different letters of a and b in each row represent a statistically significant difference at the 95% confidence interval.

The volume (width x length x thickness) and weight of male sea salt grains before and after the experiment were different ($p<0.05$). The mean volumes before and after the experiment were 2.49 ± 0.02 and 2.19 ± 0.04 cubic cm. The mean weights were 1.47 ± 0.03 and 1.22 ± 0.04 grams, respectively.

Therefore, the mean volume and weight of male sea salt after the experiment were statistically decreased compared to before the experiment (Table 3).

Table 4. Volume and weight of female sea salt before and after the experiment.

	Pot 1	Pot 2	Pot 3	average
summary volume of salt grains				
Before the experiment (cm^3)	1.45	1.12	1.26	1.28 ± 0.17[a]
After the experiment (cm^3)	0.86	0.89	1.08	0.94 ± 0.12[a]
Weight of salt grains				
Before the experiment (g)	0.84	0.93	0.79	0.85 ± 0.07[a]
After the experiment (g)	0.80	0.74	0.74	0.76 ± 0.03[a]

The volume (width x length x thickness) and weight of female sea salt grains before and after the experiment were not different ($p<0.05$). The mean volume before and after the experiment was 1.28 ± 0.17 and 0.94 ± 0.12 cubic cm. The mean weights were 0.85 ± 0.07 and 0.76 ± 0.03 grams, respectively.

Therefore, the mean volume and weight of female sea salt before and after the experiment were not different ($p\geq0.05$) (Table 4).

Part 3: Results of the heat retention experiment of male and female sea salt

Table 5. Time and temperature of heating and time of heat retention of male sea salt

	Pot 1	Pot 2	Pot 3	average
Salt ripening time				
Round 1 (minutes)	12.18	12.33	13.00	12.50 ± 0.44^{a}
Round 2 (minutes)	15.05	16.32	16.55	15.97 ± 0.81^{b}
Round 3 (minutes)	19.12	17.14	17.55	17.93 ± 1.05^{c}
Round 4 (minutes)	19.45	19.13	19.07	19.22 ± 0.20^{d}
Round 5 (minutes)	22.30	22.08	22.17	22.18 ± 0.11^{e}
Salt ripening Temperature				
Round 1 (°C)	62.40	63.90	64.20	63.50 ± 0.96^{a}
Round 2 (°C)	83.90	83.10	82.60	83.20 ± 0.66^{b}
Round 3 (°C)	88.80	91.50	88.10	89.47 ± 1.80^{c}
Round 4 (°C)	95.10	99.40	91.60	95.37 ± 3.91^{d}
Round 5 (°C)	102.60	103.50	105.70	103.93 ± 1.59^{e}
Heat retention time				
Round 1 (minutes)	175	180	170	175.00 ± 5.00^{a}
Round 2 (minutes)	170	175	165	170.00 ± 5.00^{ab}
Round 3 (minutes)	160	170	160	163.33 ± 5.77^{bc}
Round 4 (minutes)	160	165	155	160.00 ± 5.00^{bc}
Round 5 (minutes)	155	165	150	156.67 ± 7.64^{c}

Annotation: 1. Different letters of a, b, c, d, and e in each row of the experimental results represent a statistically significant difference at the 95% confidence interval.

2. Heat retention time from the temperature in heating the salt until the temperature has decreased to room temperature during the experiment (34 degrees Celsius)

The mean times for heating the male sea salt in rounds 1-5 were 12.50 ± 0.44, 15.97 ± 0.81, 17.93 ± 1.05, 19.22 ± 0.20, and 22.18 ± 0.11 minutes, respectively. The mean temperatures for heating the male sea salt in rounds 1 -5 were 63.50 ± 0.96, 83.20 ± 0.66, 89.47 ± 1.80, 95.37 ± 3.91, and 103.93 ± 1.59 degrees Celsius, respectively (Table 5). The times and temperatures at which male sea salt was heated in each cycle differed ($p<0.05$). Meanwhile, the heat retention time of male sea salt from the temperature in heating the salt until the room temperature during the experiment (34 degrees Celsius) in rounds 1-2 was not different ($p\geq0.05$). The difference in heat retention time of male sea salt was observed from round 3 onwards when compared to round 1, with the mean heat retention times in rounds 1-5 being 175.00 ± 5.00, 170.00 ± 5.00, 163.33 ± 5.77, 160.00 ± 5.00, and 156.67 ± 7.64 minutes, respectively (Table 5).

Thus, the male sea salt was heated in each round. Also, more time was required according to the number of rounds. In contrast, the heat retention time of male sea salt was less when the number of rounds for heating the salt increased.

Table 6. Time and temperature of heating and time of heat retention of female sea salt

	Pot 1	Pot 2	Pot 3	average
Salt ripening time				
Round 1 (minutes)	12.17	12.07	10.57	11.60 ± 0.90^{a}
Round 2 (minutes)	15.38	14.44	12.55	14.12 ± 1.44^{ab}
Round 3 (minutes)	18.37	18.57	18.39	18.44 ± 0.11^{b}
Round 4 (minutes)	20.15	28.36	29.43	25.98 ± 5.08^{c}
Round 5 (minutes)	29.37	29.25	29.44	29.35 ± 0.10^{c}
Salt ripening Temperature				
Round 1 **(℃)**	71.20	74.00	69.30	71.50 ± 2.36^{a}
Round 2 **(℃)**	70.30	69.60	74.00	71.30 ± 2.36^{a}
Round 3 **(℃)**	79.80	91.80	80.20	83.93 ± 6.82^{ab}
Round 4 **(℃)**	88.10	119.00	93.70	100.27 ± 16.46^{bc}
Round 5 **(℃)**	123.00	106.10	109.50	112.87 ± 8.94^{c}
Heat retention time				
Round 1 (minutes)	160	165	160	161.67 ± 2.89^{a}
Round 2 (minutes)	145	160	150	151.67 ± 7.64^{a}
Round 3 (minutes)	130	140	130	133.33 ± 5.77^{b}
Round 4 (minutes)	130	135	130	131.67 ± 2.89^{b}
Round 5 (minutes)	125	110	110	115.00 ± 8.66^{c}

Annotation: 1. Different letters of a, b, c, d, and e in each row of the experimental results represent a statistically significant difference at the 95% confidence interval.

2. Heat retention time from the heated temperature of the salt until room temperature during the experiment (34 degrees Celsius)

The time and temperature for heating the salt, including the time of heat retention of female sea salt in rounds 1-2, were not different ($p \geq 0.05$). However, the differences in the time and temperature in heating the female sea salt began from round 3 onwards compared to round 1 ($p < 0.05$). The mean times in heating the female sea salt in rounds 1-5 were 11.60 ± 0.90, 14.12 ± 1.44, 18.44 ± 0.11, 25.98 ± 5.08, and 29.35 ± 0.10 minutes, respectively. The mean temperatures in heating the female sea salt in rounds 1-5 were 71.50 ± 2.36, 71.30 ± 2.36, 83.93 ± 6.82, 100.27 ± 16.46, and 112.87 ± 8.94 degrees Celsius, respectively. The mean times for heat retention were 161.67 ± 2.89, 151.67 ± 7.64, 133.33 ± 5.77, 131.67 ± 2.89, and 115.00 ± 8.66 minutes, respectively (Table 6).

Therefore, the female sea salt was heated in each round. There was a tendency to require more time according to the number of rounds. Heat retention time was likely to decrease as the number of rounds increased.

Table 7. Comparison of time/temperature for salt heating and heat retention of male and female sea salt

Round	Male sea salt			Female sea salt		
	Salt ripening time (minutes)	**Salt ripening Temperature (℃)**	**Heat retention time (minutes)**	**Salt ripening time (minutes)**	**Salt ripening Temperature (℃)**	**Heat retention time (minutes)**
1	12.50 ± 0.44^{Aa}	62.80 ± 1.80^{Aa}	175.00 ± 5.00^{Aa}	11.60 ± 0.90^{Aa}	71.50 ± 2.36^{Ab}	161.67 ± 2.89^{Ab}
2	15.97 ± 0.81^{Ba}	83.20 ± 0.66^{Ba}	170.00 ± 5.00^{ABa}	$14.12 \pm 1.44A^{Ba}$	71.30 ± 2.36^{Ab}	151.67 ± 7.64^{Ad}
3	17.92 ± 1.05^{Ca}	89.47 ± 1.80^{Ca}	163.33 ± 5.77^{BCa}	18.44 ± 0.11^{Ba}	83.93 ± 6.82^{ABa}	133.33 ± 5.77^{Bb}
4	19.22 ± 0.20^{Da}	95.37 ± 3.91^{Da}	160.00 ± 5.00^{BCa}	25.98 ± 5.08^{Cb}	97.90 ± 11.44^{BCa}	131.67 ± 2.89^{Bb}
5	22.18 ± 0.11^{Ea}	103.93 ± 1.59^{Ea}	156.67 ± 7.64^{Ca}	29.35 ± 0.10^{Cb}	112.87 ± 8.94^{Ca}	115.00 ± 8.66^{Cb}

Annotation: 1. Different letters of A, B, C, D, and E in each column represent a statistically significant difference at the 95% confidence interval.

2. Different letters of a and b in each row represent a statistically significant difference at the 95% confidence interval.

The study results for male sea salt's time and temperature heating in rounds 1-5 were different ($p<0.05$). The time for heat retention of male sea salt began to differ ($p<0.05$) from round 3 onwards when compared to round 1.

For female sea salt, the time and temperature for heating and the time of heat retention for female sea salt in rounds 1-2 were not different ($p\geq0.05$). The difference in the time and temperature for heating female sea salt began from round 3 onwards compared to round 1 ($p<0.05$).

When comparing the results of times and temperatures for heating male and female sea salt in rounds 1-5, there was no difference in the time for heating male and female sea salt in rounds 1-3 ($p\geq0.05$). In contrast, the temperature for heating male and female sea salt differed ($p<0.05$) in rounds 1-2. The heat retention time of male and female sea salt differed ($p<0.05$) in every experiment round. Moreover, the size of male sea salt grains was more significant than that of female sea salt grains. When both types of salt were heated following the salt pot compress method in Thai traditional medicine, the size of salt grains became smaller. Therefore, the heat retention time of salt could decrease with the number of cycles used to heat the salt.

4. Conclusions

Larger matter has a higher heat storage capacity than smaller stuff. This experiment involves transporting heat, heat energy, and salt grains by heat conduction, which transfers heat through a solid material-areas of high temperatures: Electric stove in a low-temperature environment. The solid medium consists of salt granules. The size of the salt grains before receiving heat and heat energy transfer in round 1 is larger than the size of the salt grains that received heat transfer and heat energy in round 1. 2-5, which is consistent with the experimental results that the temperature in the salt can be maintained better in the first cycle of transferring heat and heat energy to the salt granules. According to rumors, as the number of cycles increases, the size of the salt grains reduces due to heat energy transfer [18]. The heat absorption theory predicts that the size of the salt granules reduces. An endothermic process absorbs energy to break bonds. Salt crystals form a crystal lattice held together by ionic connections. It takes energy to break bonds. If it is particularly huge, breaking the bonds will need significant energy. As a result, the salt particles vibrate faster when providing thermal energy to a salt pot. The heat energy destroys the bonds that hold the salt granules together. This makes huge salt granules smaller [19]. And, while the size of the salt grains decreases with the number of cycles, the density of the salt grains inside the pot grows. According to Pascal's hypothesis, the time and temperature required to cook the salt increase with each cycle. (Pascal's Principle) states that when pressure changes in one part, the change is transferred to all other parts with the same value. The time required for energy transfer varies according to the pressure change.[20]

In conclusion, the ripening periods and temperatures of male and female sea salt were comparable in each study. However, the heat retention times of male and female sea salts retained heat for a longer period than that of female sea salts in all rounds of the experiment. As a result, male sea salt outperforms female sea salt in heat retention.

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Conflicts of Interest:

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