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ORIGINAL ARTICLE

Study on the Specific Heat of Different Types of Animals Meats

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ABSTRACT
This paper, is attempting to measure the specific heat for Muzekah and dead meats for different types of animals. Experiments were carried out using a Calorimeter method and heater plate method. The specific heat of Muzekah meats for chickens, sheep, goat, cow, camel and fish as well as slaughtered chicken without pronouncing the name of Allah (SWP) and dead chicken meats and pork were measured using the two methods. The results in both methods indicate that the specific heat of Muzekah meats of chicken, sheep, goat, cow and camel were higher than that of SWP , dead chicken meats and pork. Large difference in temperature (ΔT) means great loss of heat due to the existence of water (blood) in the meat. The obtained results are in significant support to the old principle of sticking of halal meat to fired charcoal which has been used to differentiate between Halal and non Halal meats.
Keywords: *Muzekah, Halal, Dead, Meats, Specific-Heat.*

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INTRODUCTION

Islamic communities significantly distrust the safety and validity of imported meat in the markets, whether it has been slaughtered within the fulfillment of Islamic requirements *Muzekah*, or not. The demand for *Muzekah* meat is very high and yet, there is not a simple scientific method to help consumers to differentiate between *Muzekah* and non-slaughtered (Dead) meat in the market [1-5]. *Muzekah* means cutting the carotid artery and the jugular blood vein and cutting the neck up to the spinal cord and then leaving the animal to die. This method is used for birds, cattle, sheep and goats, whereby the animal is laid down on its right side and the blood carrying arteries and veins are cut. The practice of *Muzekah* method in Islam has always been to apply a sharp blade to the neck of the animal. There are six main conditions for *Muzekah* as follows: the person who slaughters must mention the name of Allah; the object used to slaughter the animal must be sharp and used swiftly; the slaughtering must be merciful; the person performing the slaughtering must faces the direction of Makkah; he must ensure that the blood is spilt from the animal.

The perceptions of risk towards animal meat vary with time and depend on the consumers groups [6-12]. It is prohibited for Muslims to eat any of the followings: any animal that died before performing the *Muzekah*, the blood and the flesh of swine, meat which has been invoked other than the name of Allah, in addition to any meat contaminated or mixed with non-Halal meat, Zindani. (2010). On the other hand, Muslims are allowed to eat seafood without slaughtering and the *Muzekah* meat of lawful animals.

Al-Qurashi, deceased in 1307 C. E. (729 A. H.), stated that "If the Municipality's personnel has doubts over whether the meat of the animals from a deceased (*not Halal*) or a *Muzekah* animal, he should casts pieces of the meat on fired charcoal, and if it sticks to the charcoal then it is *Muzekah*, and if it did not stick it is from a deceased animal, [1].

The aim of this study is to validate this statement by analyzing why the *Muzekah* meats and fish stick on fired charcoal. The specific heats were measured and used to validate and justify the statement.

The specific heat (specific thermal capacity) of a material tells us how much energy is needed to change the temperature of one kilogram of the material by one degree. The specific heat of water c_{water}= 4186 J/kg K is the largest among all common materials. It means that water can give off or take in large quantity of heat with little change in temperature [13]**.** This study was carrying out to validate Al-Qurashi s statement by analyzing why the *Muzekah* meat sticks onto the fired charcoal, in order and to identify a suitable detecting mechanism that can use to differentiate between the meats produced by *Muzekah* meat and other methods of slaughtering [1].

Blood Volume According to the Method of Slaughtering:

Blood accounts about 8 % of the body weight of animals, varying with the species and the stage of life [14-15]. A circulating blood volume in fish ranging from 1.5 % to 3 % of the body weight, however, the most of it located in the internal organs [16-20]. The remaining blood in properly slaughtered animals is only one third (1/3 ≅ 33.3) of the total blood in the living animal or less [21]. On the other hand, the meat of stunned animals contains more than 50 % of the total blood volume. The stunning is considered as improper way of killing animals, where it usually kills the animals before bleeding. the stunning affects the central nerve system of the animal and interferes with the drainage of blood [21-24].

Table 1: Methods of Slaughtering and the blood volume % that remaining in the meat.

No	Type of Slaughtering	Its effect	Blood % remaining in the meat
1	*Muzekah* (Islamic method)	Removed 66.7 % of the blood volume from the meat the remaining blood is not harmful.	33.3 % of the blood volume; which equivalent to 2.67 % (1/3x8) from the meat weight. [14].
2	Slaughtering after stunning (non-Islamic methods)	Removed about 50% from the meat	50% of the blood volume is reaming. Equivalent to 4% from the meat weight.
3	Dead animals	All the blood is remaining.	100% of the blood volume Equivalent 8 % from the body (meat) weight' [16].
4	Fish	All the blood is remaining	100% of the blood volume Equivalent 1.5-3 % from the body (meat) weight, [16].

Variant slaughtering methods causes different quantity of the blood in the meat (Table 1). If the size of the meat is fixed while varying method of slaughtering, different amount of blood will exist in the meat. The different methods will drain different quantity of the blood from the meat, which may result in different values of specific heats. Therefore, the specific heats of the meats will be investigated.

The Physics Behind The Sticking Ability of Meat

Previously, it was stated that: "If the Municipality's personnel has doubts over whether the meat of the animals is from a deceased (*Not Halal*) or a *Muzekah* animal he should cast piece of the meat on fired charcoal. If it sticks to the charcoal then it is *Muzekah*, and if it did not stick then it's from a deceased animal. In order to justify why the *Muzekah* meat sticks on fired charcoal, the concept of the specific heat is used. It is an important measurement for engineers and physicists who work with any material that changes its temperature or its design to retain thermal energy. The heat energy, Q, lost by the fired charcoal is gained by the meat, therefor:

$$\boldsymbol{Q_{lost} = Q_{gain} = M_C c_C \Delta T_C = m_m c_m \Delta T_m} \quad (1)$$

Where M_C, c_C and ΔT_C are respectively the mass, the specific heat and the change in temperature of the fired charcoal, and m_m, c_m and ΔT_m are the mass, the specific heat and the change in temperature of the meats, respectively.

Thus,

$$\boldsymbol{c_m = \frac{M_C c_C \Delta T_C}{m_m \Delta T}} \quad (2)$$

Since the dead animal's meat contains 100% quantity of the blood, meaning it contains a large quantity of water that has largest specific heat among any substances, c_{water} =4180 J/ kg K. Referring to equation (2), the quantity mass times the change in temperature, $m_m\Delta T_m$, has a significant effect and is inversely proportional to the value of the specific heat c_m. Therefore, it is assumed theoretically, that the specific heat of Muzekah meat should be larger than that of the Dead meat because its quantity, $m_m\Delta T_m$ is smaller and is unable to put off the fired charcoal and instead it sticks onto it.

MATERIALS AND METHODS

Collection of samples

One-month-old chickens (n = 15) were obtained immediately from the slaughters. The chickens were

hydroid strains and their weights ranged between 1.5-1.75 kg. Each chicken was kept, immediately after slaughtering, in a sterilized container, and transported under aseptic conditions at the Laboratory at the Faculty of Science, University of Hail. While (5.0 kg) of the ready slaughtered fresh meat of each sheep, goat, cow, camel and fish were collected from local marketing Hail, KSA. For the second method of testing (Heating Plate Method) ready fresh fish and pork meats were supplied by Restaurant of the MARRIOTT HOTEL MANILA, Philippine, in this study.

Methods of slaughtering

***Muzekah* method**

The chicken was put in a chicken killing cone. The head was pulled out through the end of the cone, and then the artery was cut just below the jaw line. The chicken was left to bleed out until the reflexes stopped, and then washed off to remove dirt. Without performing the condition in the *Muzekah* method, the caught chicken will be put in the jaw line, slaughtered without pronouncing the name of Allah (SWP), the head was pulled out through the end of the cone, and then the artery was cut just below the jaw line. Waiting for the reflexes to stop, bleed out until it has expired and then washing the bird off to remove feces and dirt.

ii. Dead method:

In order to keep all the amount of blood within the meat, the chicken neck was dislocated immediately and died out.

iii. Preparation of meat samples

Poultry meat samples were prepared for analysis, which included: *Muzekah,* SWP and dead chicken meats. All the chicken meats were chilled immediately within two hours of slaughtering to 5 °C to insure the prompt removal of the animal heat and preserve the wholesomeness of the products. Each meat sample was divided in two parts, one part was packed, sealed, chilled, and kept as a reference. The other part was chilled for 24 hours and then used for analysis.

Measuring the Specific heat of the Meat Samples Using Calorimeter

A set of three Calorimeters have been used in the laboratory in order to measures the specific heat of the samples. The initial temperature of calorimeter that was filled with 200 g of water was recorded. The weight of the meat samples was kept 35.5 g and heated for an initial temperature of 98 °C. The heated meat sample was dropped into the water-filled calorimeter and the mixture were kept and observed till reached the equilibrium point and then recorded as final temperature. The experiment was repeated 5 times for each type and the average specific heats for each type were calculated using the following equation.

$$\boldsymbol{m_W c_W \Delta T_{CW} + C_C \Delta T_{CW} = m_m c_m \Delta T_m} \quad (3)$$

Thus, specific heats of each meat sample, c_m, was obtained as:

$$\boldsymbol{c_m = \frac{m_W c_W \Delta T + C_C \Delta T}{m_m \Delta T}} \quad (4)$$

Where m_w and c_W are the mass and specific heats of water, ($c_W = 4181$ J/kg K), C_C is the heat capacity of the Calorimeter which equals to 90 J/K. ΔT_{CW} and ΔT_m are the change in temperature for both Calorimeter and water and each meat sample, respectively. While m_m is the mass of meat sample. The experiments were repeated 5 times for each sample of meat *Muzekah,* SWP and Dead chickens, fish, goat, cow and camel meats. The average specific heats of each sample of meat were calculated and are shown in the results' section. Figure 1: shows a set of Calorimeters using to measure the specific heat of the samples meats.

Figure 1: Shows a set of Calorimeter using to measure the Specific Heat of the samples meats

Measuring the Specific heat of the Meat Using the Heater Plate.

Two electrical heaters with commercial heating plates, that are used for burning charcoal were used for measuring the specific heat of the meat samples. One of the heating plates was detached from the heater and used for measuring its specific heat while keeping the second one in its location. A Calorimeter set celebrated with its value heat capacity was used. The heating plate was weighed and heated up to 150 °C, which was considered as its initial temperature then the calorimeter was filled with water till 250 mL and recorded its temperature as initial value. The heated plate was dropped into the water-filled calorimeter and the mixture was kept and observed till reached the equilibrium point and the final temperature was recorded. This experiment steps were repeated 10 times and the specific heats of the heating plate were calculated using the following equation.

$$\boldsymbol{m_W c_W \Delta T_{CW} + C_C \Delta T_{CW} = M_P c_P \Delta T_P} \quad (4)$$

Thus, specific heats of the heating plate, c_p, was obtained as:

$$\boldsymbol{c_P = \frac{m_W c_W \Delta T + C_C \Delta T}{M_P \Delta T}} \quad (5)$$

Where m_w and c_W are the mass and specific heats of water, (c_W =4181 J/kgK), C_C is the heat capacity of the Calorimeter which equals to 90 J/K.ΔT_{CW} and ΔT_P are the change in temperature for both Calorimeter and water and the heating plate, respectively. While M_p is the mass of the plate. The specific heat of the heating plate, c_p, has been calculated to give 330.1 J/kg K which indicates that the material of the plate was an alloy and closed to the Brass (c_{Brass} =380 J/kg K). Consequently, the average of the specific heat of the heating plate can be used to calculate the specific heat of the meat instead of the hot coal.

The second electrical heater was connected and heated up to the range 150 °C, and then disconnected from the power supply when the temperature on the digital thermometer stopped rising, it was registered as the initial temperature with its weight. The initial temperaturesof25 grams meat were measured. The piece of meat was immediately dropped on the heater. After the equilibrium state was reached, the final temperatures were recorded and the specific heats of meat samples were calculated using the following equation:

$$\boldsymbol{c_m = \frac{Q}{m_m \Delta T_m} = \frac{M_P c_P \Delta T_P}{m_m \Delta T_m}} \quad (6)$$

The experiments were repeated ten times for each sample of meats (*Muzekah* and Dead chickens, fish and pork meats). The average specific heats of each sample of meat were calculated.

RESULTS AND DISCUSSIONS

Measuring Specific Heat of Meats Using Calorimeter Method

Figure (2)shows the average specific heats of *Muzekah* chickens (Chi) followed by fresh, ready slaughtered camel, cow, sheep, goat and ship meats respectively. In addition the end-right of the graph represents the specific heats of SWP and dead chicken (D-Chi) meats. The difference ΔT makes the variation of the results when plugged into equation (6), keeping into account that all samples have same mass (m_m =35.5 g). Small values of ΔT mean higher specific heats, while large values mean small specific heat of meat type. Moreover, it can be seen that all *Muzekah* and fish samples showed large values of specific heats which corresponds to petite absorption of heat due to the less of blood content.

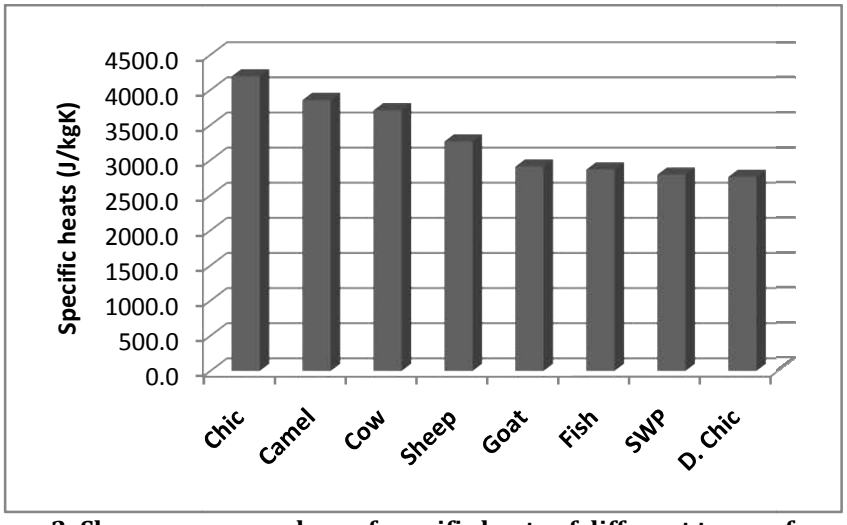

Figure 2: Shows average values of specific heats of different types of meats.

Also, there is a significant observations here in the location of the specific heat of fish in the graph, where it is located between *Muzekah* and Dead chickens. As we know the fish (seafood) is lawful and *Halal* in its original and it is a natural standard or reference for *Halal* meat. Meats that have specific heat greater than the fish should stick on fired charcoal and well-thought-out are *Halal*. Whereas, meats that have specific heats less than the fish should not stick on fired charcoal and considered as non *Halal*.

Measuring Specific Heat of Meats Using Heater Plate Method

In Figure (3), the *Muzekah* chickens and fish have large average of the specific heats compared to dead chicken meat and pork. As mention before, also ΔT makes the variation of the results when plugged into equation (6). Thus small values of ΔT mean higher specific heats, while large values of ΔT result in small specific heat of meat type. As a result, the dead chicken meat and pork showed small values of specific heat with large change in ΔT, this is due the existence of blood that contains much water.

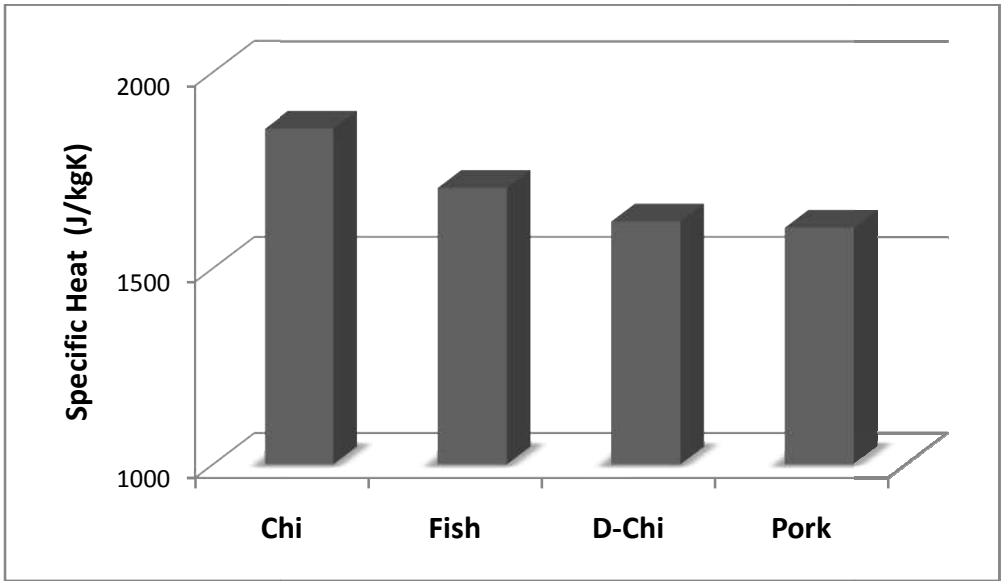

Figure 3: Shows the Specific Heats of *Muzekah* chicken, Fish, Dead chicken and Pork

Thus, from the results shown, the higher specific heats of the *Muzekah* samples are in agreement with Qurashi's statement that "if a municipal employee has doubts over the meat whether it is Halal or not, he should cast a piece of the meat on fired charcoal, and if it sticks to the fired charcoal then it is *Muzekah*, and if it did not stick then it is from a deceased animal. While the higher change in ΔT indicates that the meat absorbs more heat energy from the fired charcoal and thereby dramatically reduces the surface temperature of the fired charcoal and does not stick on it. Consequently, this indicates clearly that, the Dead chickens and pork meats can absorb more heat from heating plate or the fired charcoal and puts it off without sticking to it. While *Muzekah* and fish meats have low values of ΔT and have not enough energy to completely reduce the surface heat of the fired charcoal dramatically but instead stick on it.

CONCLUSIONS

Up to over knowledge, there is no intelligent device or a specific mechanism available for consumers to check whether the meat is *Muzekah* or not. It was found that both the *Muzekah* meat and fish have large averages of specific heats. The higher change in ΔT shows that the meat absorbs the heat of the fired charcoal dramatically reducing its surface temperature and does not stick on it. While *Muzekah* and fish meats have low values of ΔT and have not enough energy to completely reduce the surface heat of the fired charcoal dramatically and thus stick on its surface. The as-obtained results are valid, confirmation and in support of Qurashi's statement about the sticking ability of *Muzekah* meat and fish (Halal Meats). This sticking ability is innovative and simple detecting mechanisms that allow to differentiate between *Halal* meats (Fish and *Muzekah* meat) and *non Halal* meats (Dead animals and meat of swine).

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