PROVISION OF SUGAR-SALT SOLUTION AS AN EFFORT TO DECREASE THE LOSS OF PIG CARCASS COMPONENTS BECAUSE OF SLAUGHTERING DELAY

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ABSTRACT

Become of the aims of this study was to determine the effects of sugar-salt solution given to pigs during periods of slaughtering delay as an effort to decrease weight losses of main physical components of their carcasses. The study used randomized complete block design and a 3 x 4 factorial treatment array. The treatments were three levels of sugar-salt solution, i.e. g_0 (had no access to the sugar-salt solution or provided with plain water only), g_1 (treated with 150 g sugar + 15 g salt solution), and g_2 (treated with 300 g sugar + 30 g salt mixture), and four levels of slaughtering delay i.e. l_0 (without slaughtering delay), l_1 (one day of slaughtering delay), l_2 (two days of slaughtering delay), and l_3 (three days of slaughtering day). The sugar-salt mixture was diluted in 1 litter of water.

Results of the study showed that there was no interaction between provision of the solution and slaughtering delay on weight of main physical components (meat, bone and fat) of the carcass. As a separate factor, however, provision of the solution or slaughtering delay alone has significantly ($P<0.05$) affected weight of the carcass components. Prolonged slaughtering delays significantly lowered ($P<0.05$) weights of dissected meat and subcutaneous fat ranging from 0.9 to 13.5%, and from 14.1 to 29.3%, respectively. Weights of bone, inter-muscular fat, and skin, however, were not significantly affected ($P>0.05$) by the slaughtering delays. Moreover, provision of the sugar-salt solution significantly ($P<0.05$) decreased the weight losses of meat and subcutaneous fat so that their weights were higher by 21.6 and 12.9% compared to control, respectively. But, the solution had no affect ($P>0.05$) on bone, intermuscular fat, and skin weights. It could be concluded that the provision of sugar-salt solution is a importen attempt to reduce losses of meat subcutaneous fat of pig carcass when fewcess have to be delayed.

Key words: pig, sugar-salt solution, slaughtering delays, and physical components of the carcass.

Introduction

Management of animals prior to slaughter should be conciderad in order to obstain good quality carcass or meat. This experiment was carried out to study the use of sugar-salt solution before slaughtered to maintain carcass quality. One thing that should be taken into account to obtain good quality of pork is the pre-slaughter treatments commonly practiced for animals prior to slaughter since it may affect on

their yield and quality of meat (Soeparno, 2011). However, butchers in Bali do not care of delaying the slaughtering time of their pigs, though such the case may lead to some disadvantages. Some pre-slaughter factors, such as nutrition, ambient temperature, frightened, muscular fatigue or prolonged exercise subjected to animals few moments before slaughtered may lead to changing metabolism of post-mortem muscles (Soeparno, 2009).

Transportation of animals from farm to the abattoir is one of the pre-slaughter treatment. During transportation, pigs may subject to stress at various levels due to over-crowd in the vehicles, high ambient temperature, and peck order, particularly during prolong travelling (Stabel and Fedorka, 2004). Furthermore, Apple *et al.* (2005) and Earth *et al*. (2009) also explained that chemically stressed animals have muscles with condition of lower glycogen and higher blood sugar levels and experienced live weight losses due to losses in water body content of the animals. When such animals were slaughtered, limited and slow postmortem glycolyses will occur. Leheska *et al*. (2011) had reported that finisher pigs subjected to fasting for 48 hours resulted in live weight losses up to 3.6%. Results of earlier study indicated that fasting for 72 hours in pigs caused live weight losses of 4% per day, and carcass weight losses of 3% per day (Starke, 1948).

Common salt, composed of sodium (Na) and chlorine (Cl), are essential for various body functions. The total body content of Na in pig is about 0.2 %. In addition of its presence in bone, Na is present largely in extracellular fluid with less than 10% within cells. Potassium (K), Na and Cl are electrolytes that play a vital role in maintaining osmotic pressure in the extracellular and intracellular fluids, and in maintaining acid-base balance. Chlorine is present almost exclusively in the extracellular fluid (Sihombing, 2006). Deficiency of Na and Cl may results in lowering appetite, depressed growth rate and efficiency of feed utilization in growing animals, and reduced milk and live weight losses in adults, and decrease components of blood composers (Soeparno, 2009).

As pre-slaughter treatments conducted by pig farmers and/or butchers in Bali, particularly those concerning with transportation or prolonged delay of slaughter may reduce the quality of pork produced and treatment with sugar-salt solution during pre-slaughter period reveal some advantages, it is then necessary to perform a study to

evaluate the affects of sugar-salt solution administration as an effort to decrease weight losses of main physical components of slaughter pig carcasses resulted from prolonged delay of slaughter.

Materials and Method

The experimental barrows, breed of Landrace crosses (Chester White x Landrace) weighing (± SD) 96 ± 1.55 kg used in this study were originated from PT. Puri Agrindo Indah (PAI) pig farming situated at the village of Tunjuk, district of Marga, regency of Tabanan about 30 km west of Denpasar. Previously, all pigs were raised in one pen and fed with finisher ration of similar quality. Time taken from the farm to the private abattoir where the pigs were slaughtered was about 60 - 68 minutes. Before the pigs were loaded on the small trucks, each individual pig was restrained by taking them into a bamboo basket (*bangsung*).

The animals used in this were 48 barrows which were randomly allotted in a randomized complete block design in 4 x 3 factorial treatment array consisting of 0 (l_0), 1 (l_1), 2 (l_2), and 3 (l_3) days of slaughtering delay , and levels of sugar-salt solution i.e. without sugar-salt solution and water (g_0), given solutions of 150 g sugar + 15 g salt (g_1), and 300 g sugar + 30 g salt mixtures (g_2) that were dissolved in 1 l water so that there were 12 treatment groups or treatment combinations with 4 barrows in each treatment group. During period of slaughtering delay, all barrows had no access to diet. All of 48 barrows studied were slaughtered in four phases (blocks) at a private abattoir at Buluh Indah Street, No.IV/8, Denpasar. In each slaughter phase (block), within 4 days, there were 12 barrows of 12 treatment groups (one barrow in each treatment group) were slaughtered and then their carcasses were dissected into three main physical components i.e. muscle, bone and fat (subcutaneous and inter-muscular fat).

During slaughtering delay (pre-slaughter rest period), all barrows were not given access to water or given sugar-salt solutions according to the treatments subjected to them. The right side of each carcass was chilled overnight at 2^0C. The cold carcasses were then cut into seven wholesale cuts as described by Aberle *et al*. (2001). Each wholesale cut was dissected into muscle, bone and fat (subcutaneous and inter-muscular fat) and they were then weighed. Data were collected every day within each

phase of slaughtering process (4 days) in slaughtering hall at the abattoir and in dissecting hall at an animal products supplier.

In this study, reference has already been made to the recording of the following measurements: slaughter weight, hot and cold carcass weight, muscle (lean meat), bone, subcutaneous and inter-muscular fat, and skin.

Data were analyzed as a randomized complete-block design using analysis of variance (Program Series 13 of SPSS) and when statistical differences between treatment means were found, the analysis was continued with the Duncan's Multiple Range Test (DMRT) for comparing the two treatment means to the limit of 5% significant difference (Steel and Torrie, 1989).

Results and Discussion

Results on the effects of slaughter delay and provision of sugar-salt solution on cold carcass weight and main physical components of the barrow carcasses were presented in Table. 1. There was no significant interaction between administration of sugar-salt solution and slaughter delay on weight of carcass physical component of the barrows. Losses of cold carcass weight were significantly decreased by 1.2, 5.5, and 11.8% when slaughtering of the l_1, l_2, and l_3 barrows were delayed for 1, 2, and 3 days, respectively. Decreases of these cold carcass weight were followed by significant decrease ($P<0.05$) in lean meat by 10.0 and 14.7%, when slaughtering was delayed by 2, and 3 days, respectively. Delay of slaughtering for only one day, however, did not significantly decrease ($P>0.05$) weight of the lean meat dissected from the l_1 carcasses. Weight of subcutaneous fat, was also significantly declined by 14.1, 20.2, and 29.3%, respectively, when the slaughter was delayed up to 1, 2, and 3 days. Weight of bone and skin, however, were not affected by prolonged slaughtering delay. Close agreement was noted between weight losses in muscles and cold carcasses. Cold carcass weight of the barrows were significantly declined ($P<0.05$) by 1.5, 5.5, and 11.8% caused by slaughter delay of 1, 2, and 3 days, respectively. Slaughtering delay did not affect the weight of bone, inter-muscular fat, and skin.

Losses in cold carcass weights were decreased so that their weights were 5.8 and 13.2% higher than those have no sugar-salt solution due to treatment of sugar-salt solution in the g_1 and g_2 barrows, respectively. Parallel with cold carcasses, provision

of sugar-salt solution significantly decreased (P<0.05) their carcass components so that their lean meat were 17.8 and 22.5%, and their subcutaneous fats were 12.9 and 16.5% higher in the barrows of g_1 and g_2, respectively, than those of g_0 barrows. Their bones, inter-muscular fats, and skins, however, were not affected by the given solution.

Table .1
Effects of Sugar-Salt Solution Provision and Slaughtering Delay on Carcass Physical Components of the Barrows

Cold carcass weight and weight or changes of carcass physical components*)								
Treatment	CC (kg)	Bone (kg)	Meat (kg)	Mwc (%)	Imf (kg)	Sc (kg)	Swc (%)	Skin (kg)
Slaughter delay								
lL_0	65,0[a]	10,2 a	31,9 [a]	0	3,5 [a]	9,9 [a]	0	9,5 [a]
l_1	64,2[b]	10,6 a	31,6 [a]	0,9	3,8 [a]	8,5 [b]	14,1	9,7 [a]
l_2	61,4[c]	10,5 a	28,7 [b]	10,0	3,4 [a]	7,9 [c]	20,2	10,9 [a]
l_3	57,3[d]	10,0 a	27,2 [c]	13,5	3,1 [a]	7,0 [d]	29,3	10.0 [a]
SEM	0,89	0,15	0,42		0,10	0,30		0,14
Sugar-salt.sol.								
g_0	59,9[A]	11,7 [A]	25,0 [A]	0	3,1 [A]	8,5[A]	0	11,8 [a]
g_1	63,4[B]	12,4 [A]	30,4 [B]	21	3,5 [A]	9,6 [B]	12,9	11,0 [a]
g_2	67,8[C]	11,4 [A]	31,6 [B]	26.4	3,8 [A]	9,9 [B]	16,5	11,1 [a]
SEM	0,77	0,13	0,30		0,87	0,26		0,17

Numbers followed by similar superscript (capital or small letters) in similar colum indicated significant difference (P<0.05). CC: cold carcass, Mwc: meat weight change, Imf:intermuscular fat, Sc: subcutaneous fat, Swc: subcutaneous fat weight change; SEM, standard error of the treatment means.

The barrows in the present study were most likely subjected to a stressful situation due to rough handling when they were loaded into the trucks, hot weather during transportation, or during unloaded from the trucks on arrival at the abattoir, encountered strange environment, smell, noisy, or high environmental temperature at the abattoir. The barrows respond with a number of physiological changes which are triggered by mechanisms in the hypothalamus. The respond was necessary in maintaining metabolic homeostasis that involve many factors, among which are the enzyme systems and the hormones.

Significant responses of meat and subcutaneous fat on sugar-salt provision during slaughtering delay were due to ante-mortem meat and subcutaneous fat make up energy stores as glycogen and fat, respectively. During delay of slaughtering time or fasting, degradation of energy reserves continually occur according with their priorities as has been mentioned above.

Muscle composed of protein, fat, water and ash and ante-mortem muscle from healthy, well fed, adequately rested animals and slaughtered without being upset or stress have adequate levels muscle glycogen i.e. about 1% of fresh muscle weight (Aberle *et al*., 2001); Soeparno, 2009). Initial step of the body response on stress need readiness of the body system with physiological, metabolism, and hormonal processes which in turn require energy in the form of glycogen to against stress. Liver releases glucose into the blood vessels in the form of glucose-6 phosphate through glycogenolysis process. Adrenaline accelerated this reaction by increasing phosphorylase activity. Further, glucose enter muscle and then changed into glycogen again. Whenever energy is required, this muscle glycogen is converted into glucose through reaction of anaerobe glycolysis due to phosphorylase activity accelerated by adrenaline. This reaction produce 2 ATP which is useful as an energy source for muscle contraction. (Cory cycle) (Stryer, 1981). A very fast process occur at the onset of stress, the case proceed in very short time, only a matter of several minutes and this condition refer to "general emergency reactions" (Dawkins, 1980).

In natural circumstances, emergency situation, in case of acute stressed animals, frequently lead to catabolism or mobilization increment of energy source i.e. free fatty acids from the triglyceride stores in fat depots in the body (carcass and internal fats). Such physiological changes are also supported by Colbert (2011) who revealed that in such situation the animal is under alarm stage of stress. Response on the alarm stage may happen not only when the animal really experience frightened situation, but also when it feel under threatened or frightened situations and dangerous. The alarm stage of stress results in increasing of adrenaline secretion in a very short time (a matter of seconds), high level of emotion is arisen, and produce extra of energy for flight and fight against danger that coming to threaten. As a whole, such process requires a lot of energy and break down fat depots of intramuscular fat in muscle, inter-muscular fat laid between muscles, and subcutaneous fats which in turn results in weight losses of the subjected components. These findings are in agreement with those of Wilcox (1953) who indicated that the experimental pigs fed sucrose during pre-slaughter rest period had carcass weight significantly 11 % higher than those had no sucrose.

A significant response of slaughtering delay on subcutaneous weight loss was also recorded in this study. This case occurs because subcutaneous fat is one of energy

store in the body in the form of fat depot or adipose tissue. During slaughtering delay or fasting, metabolism of carbohydrate, protein and lipid, is increased due to glucocorticoids (cortisol, corticosterone, and cortisone) activation which is released by adrenal cortex. Among carcass fats, subcutaneous fat has the first priority to be broken during fasting and make up the latest adipose tissue stored in the carcass. Lipolysis of triglyceride stores of adipose tissue into free fatty acids and glycerol is aimed at synthesizing glycogen (as energy store) through process of glyconeogenesis. This case was supported by the research findings of Starke (1948) that live weight loss experienced by starved animals during a period of starvation immediately before slaughter can be replaced by providing the animals with access to water and to feed. When an animal is fasted, live weight falls because the normal life or physiological processes of the body continue (Starke, 1948).

In order to meet this normal life, energy sources in the body are used at the expense of protein, fat and glycogen store in the liver and muscles. Results of recent study conducted by Nancy *et al*. (2012) also confirmed that glyconeogenesis process from lactic acid into glycogen in stress experienced pigs is slower than those had no stress (in relax condition). This case hamper formation of glycogen in the liver so that catabolism of energy stores in the liver, muscles and adipose tissue of the body continue during the animal subjected to starvation and stress. This occurrence results in losses of the muscle and adipose tissues of the body. Similar argumentation was also proposed by Leheska *et al.* (2011) that pigs fasted for 48 hours resulted in carcass weight loss of 3.6%; their carcass fats, however, were not significantly reduced.

Provision of sugar-salt solution significantly reduced losses of some carcass physical components. These results indicated that the solution given to the pigs had been used by the fasted pigs during the slaughtering delay in order to meet their energy and water requirement (rehydration) for sustaining their continual metabolism in their bodies. These findings supported the viewpoints of Aberle *et al*. (2001) and Soeparno (2011) that some muscles of pork are classified as ‘white” meats due to high content of the white fibers in the muscles and characteristic of II B meat type with high concentration of glycogen, high rate of muscle contraction and so has high glycolitic activity. The glucocorticoids and mineralocorticoids require glucose and mineral for their respective functions and the sugar-salt solution given to the experimental pigs was

required as sources of energy and mineral to recover the glucose and mineral lost during slaughtering delay or fasting. The provision of the sugar-salt solution during slaughtering delay was suitable and has some advantages in reducing weight losses of the muscles and subcutaneous fat of the pig carcasses. This opinion was in agreement with that of Frandson (1992) who proposed that the provision of sugar-salt solution (the G-G solution) was frequently called as oral rehydration. The main ingredients of this solution are common salt (NaCl) and palm sugar (glucose or sucrose) with the solution composed of sodium chloride (NaCl), anhydrate glucose, sodium bicarbonate. This solution mixture with sodium and chlorine contents, together with potassium are all electrolytes that play a vital role in maintaining osmotic pressure in the extracellular and intracellular fluids, and in maintaining acid-base balance and so are able to decrease the affect of dehydration. Therefore, the sugar-salt solution was recommended as *oralit* solution due to its ability to reduce the effects of dehydration and to refill the body fluid loss.

Masmamad (2010) as cited by Ardani (2012) supported the viewpoint mentioned above who revealed that sugar-salt combination is readily absorbed by the animal's gut wall which is under stress condition and experiencing dehydration since the sodium ion functions as an allosteric (in the relation to the constraint of enzyme action which combining with another molecule). In addition, salt has a capability in increasing transportation and increase the absorption rate of sugar through cell membrane. The mixture of sugar and common salt (NaCl) is also able to increase water absorption of the gut wall and therefore dehydration of body fluids can be reduced.

Based on the present results, it was concluded that slaughtering delay resulted in weight losses of meat from 0.9 to 13.5 % and subcutaneous fat from 14.1 to 29.3 %. Bone, skin and inter-muscular fat, however, were not affected by the slaughtering delay. Provision of sugar-salt solution was able to reduce weight losses of the carcass physical components.

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