Effect of Bedding Materials and Stocking Density on Growth Performance, Carcass Characteristics, and Contact Dermatitis in Broiler Chickens

Kang Ly

A Thesis Submitted in Fulfillment of the Requirements for the Degree of Master of Science in Animal Science

Prince of Songkla University

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Major Program	Animal Science

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This is to certify that the work here submitted is the result of the candidate's own investigations. Due acknowledgement has been made of any assistance received.

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I hereby certify that this work has not been accepted in substance for any degree, and is not being concurrently submitted in candidature for any degree.

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ชื่อวิทยานิพนธ์ ผลของวัสดุรองพื้นและความหนาแน่นต่อการเจริญเติบโต ลักษณะซาก และผิวหนังอักเสบในไก่เนื้อ

ผู้เขียน Mr. Kang Ly

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บทคัดย่อ

การศึกษาครั้งนี้แบ่งออกเป็น 2 การทดลอง เพื่อศึกษาผลของการใช้ทางใบปาล์มน้ำมันสับ และแกลบเป็นวัสดุรองพื้นต่อสมรรถนะการเจริญเติบโต ลักษณะซาก และโรคผิวหนังอักเสบในไก่เนื้อ ในการทดลองแรกใช้สัดส่วนระหว่างแกลบและทางใบปาล์มน้ำมันสับเป็นวัสดุรองพื้น โดยแบ่งเป็น 5 กลุ่ม คือ แกลบ 100 % (T1) แกลบ 75 % : ทางใบปาล์มน้ำมันสับ 25 % (T2) แกลบ 50 % : ทางใบปาล์มน้ำมันสับ 50 % (T3) แกลบ 25 % : ทางใบปาล์มน้ำมันสับ 75 % (T4) และทางใบปาล์มน้ำมันสับ 100 % (T5) จากการศึกษาพบว่าวัสดุรองพื้นมีความสามารถในการดูดซับน้ำ โดยไม่มีผลกระทบต่อปัญหาสุขภาพของไก่ อย่างไรก็ตามผลการศึกษาพบว่าไก่มีน้ำหนักตัวสูงสุดและต่ำสุดใน T4 และ T2 ตามลำดับ (P>0.05) จึงอาจสรุปได้ว่าการใช้ T4 เป็นวัสดุรองพื้นสามารถนำไปใช้ในการผลิตไก่เนื้อได้อย่างมีประสิทธิภาพ การทดลองที่ 2 ใช้วัสดุรองพื้น 3 ชนิด และเลี้ยงไก่ด้วย 2 ความหนาแน่น โดยวัสดุรองพื้นประกอบด้วยทางใบปาล์มน้ำมันสับ 100 % ทางใบปาล์มน้ำมันสับ 75 % : แกลบ 25 % และทางใบปาล์มน้ำมันสับ 50 % : แกลบ 50 % ส่วนความหนาแน่นของการเลี้ยงไก่เนื้อ คือ 10 และ 15 ตัว/ตารางเมตร ผลการทดลองชี้ให้เห็นว่าไม่พบปฏิสัมพันธ์ร่วมระหว่างวัสดุรองพื้นกับความหนาแน่นของการเลี้ยงไก่เนื้อ (P>0.05) อย่างไรก็ตามความหนาแน่นของการเลี้ยงไก่เนื้อส่งผลต่อคุณภาพของวัสดุรองพื้น และการเจริญเติบโต โดยการเลี้ยงไก่ด้วยความหนาแน่น 10 ตัว/ตารางเมตร มีผลให้ ความชื้น pH ความหนาแน่นของวัสดุรองพื้น แอมโมเนีย และการเกิดโรคผิวหนังอักเสบที่เท้าต่ำกว่าการเลี้ยงไก่เนื้อด้วยความหนาแน่น 15 ตัว/ตารางเมตร (P<0.05) เมื่อสิ้นสุดการทดลองไก่ที่เลี้ยงด้วยความหนาแน่น 10 ตัว/ตารางเมตร มีน้ำหนักตัวเฉลี่ยสูงกว่า และมีค่าประสิทธิภาพการใช้อาหารต่ำกว่าการเลี้ยงด้วยความหนาแน่น 15 ตัว/ตารางเมตร (P<0.05) จึงสรุปได้ว่าความหนาแน่น 10 ตัว/ตารางเมตร เหมาะสมต่อการเลี้ยงไก่และช่วยให้ไก่มีการเจริญเติบโตดีกว่าการเลี้ยงด้วยความหนาแน่น 15 ตัว/ตารางเมตร

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ABSTRACT

Two experiments were conducted to understand the bedding materials and the effects of oil palm frond stems and rice husks to produces on broiler chicken growth performance, carcass characteristics and contact dermatitis. In the first experiment, bedding materials were used as ratio between rice husks and oil palm frond stems that composed with 100 % rice husks (T1), 75 %:25 % rice husks and oil palm frond stems (T2), 50 %:50 % rice husks and oil palm frond stems (T3), 25 %:75 % rice husks and oil palm frond stems (T4) and 100 % oil palm frond stems (T5) to determine by broiler reared. From the studied, bedding materials showed associate function to absorb capacity of bedding quality that did not affected a problem on chicken's health. Nevertheless, the result showed the highest and the lowest body weight were in T4 and T2 ($P>0.05$), respectively. That may conclude T4 could be used successfully reared on broiler production. The second experiment, composed with 3 bedding materials and 2 stocking densities, 100 % oil palm frond stems, 75 %:25 % oil palm frond stems and rice husks and 50 %:50 % rice husks and oil palm frond stems were reared with 10 and 15 of broiler chicks/m^2. The result showed that no interaction between different bedding materials and stocking density on broiler reared ($P>0.05$). However, stocking density showed significantly affected on bedding quality and growth performance. Stocking density with 10 chicks/m^2 found that moisture content, pH, bulk density, ammonia and incidence on footpad dermatitis were lower than 15 chicks/m^2 ($P<0.05$). At the end of experiment chickens that rearing with stocking density of 10 chicks/m^2 had greater average final body weight and also had lower FCR than 15 chicks/m^2 ($P<0.05$). In conclusion, the stocking density of 10 chicks/m^2 was suitable on chicken rearing and promoted on growth performance better than 15 chicks/m^2.

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Kang Ly

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THE LIST OF ABBREVIATIONS

BD	: bulk density
cm	: centimeters
CP	: crude protein
ºC	: degree celsius
EFB	: empty fruit bunches
E. coli	: *Escherichia coli*
FPD	: footpad dermatitis
MC	: moisture content
m	: meters
OPFS	: oil palm frond stems
OPF	: oil palm frond
OPT	: oil palm trunk
PKC	: palm kernel cake
POME	: palm oil mill effluent
PPF	: palm press fiber
%	: percentage
RH	: rice husks
WHC	: water holding capacity

CHAPTER I
INTRODUCTION

1.1 Research background

In intensive commercial broiler production, broiler chickens are typically raised in a closed house with bedding materials on a floor and to provide a protective cushion. As poultry production increase, the amount of bedding material required by the structure is also increased. Bedding material was a necessary role in poultry rearing. Chickens could be used the bedding material to make the environmental production, to absorb excess moisture, dropping to control reasonably dry and to ensure comfortable condition in the poultry farm. Moreover, these factors influence the efficiency of litter types including bedding materials, size of the litter, moisture content, pH, caking rate litter 5-10 centimeters depth, improper management of the drinkers, feathers, spilled feed, cooling and ventilation system, and stocking density (Parkhurst and Mountney, 1988; Farghly, 2012).

However, bedding quality may effected by stocking density because proper stocking density was an important management consideration in poultry rearing. High stocking density of broilers may have a deleterious effect on bedding material and environmental condition in house and adversely affect poultry, health and performance (Dozier *et al.*, 2005; Farhadi *et al.*, 2016). Others factors related to high density and bedding material may also contribute to reducing performance, high ammonia emission and reducing access to feed and water (Feddes *et al.,* 2002). Therefore, foot problems were among the most dangerous welfare problems in intensive commercial broiler production, but an effective evaporation system will minimize the problem (European, 2000). Optimum stocking density will maximize productivity because chicken growth performance is damagingly affected by high stocking density. The effects of various bedding types and stocking density on performance, carcass, and quality of bedding must be evaluated, and alternative sources of low cost bedding must be sought. However, bedding system is the most popular system of housing in chicken production throughout the world and helps promote the evaporation of moisture and ammonia emission in the air (Sharma *et al.,* 2015).

Many researchers used bedding materials to cover the floor such as wood shaving, sawdust, rice hulls, wheat straw, pine wood chips, peanut hulls, coconut hulls, sand, and recycle paper rolls (Swain and Sundaram, 2000; Huang *et al.,* 2009; Atencio *et al.,* 2010; Toghyani *et al.,* 2010). Due to the efficiency of a special bedding substrate is effected by the size of a particle, moisture content, water holding capacity, and building up and some of the physical and chemical characteristics (Garces *et al.,* 2013). Bedding types may be significant on growth performance, carcass quality, health, and affects litter consumption and the welfare of broiler chicken (Atapattu and Wickramasinghe, 2007; Toghyani *et al.,* 2010; Garces *et al.,* 2013). Furthermore, some of the bedding materials had an influence on litter physical properties, structure, and response to water absorption, dry release, and biochemical processes (Dunlop *et al.*, 2016b). Also, high moisture content of bedding materials have harmful effects on the birds' health. Wetness resulted in litter decomposition, ammonia production, a hazard for footpad dermatitis and pathogenic microbial populations and increased the risk of respiratory diseases (Monira *et al.,* 2003; Swain and Sundaram, 2000; Ramadan and El-Khloya, 2017). Consequently, the litter should be available with a possible moisture absorbing capacity, non-toxic, and important to avoid high bacterial load.

Currently, rice husks (RH) are also extensively used as a raw material for biofuel and biomass power plants in Thailand (Ueasin *et al.,* 2015). Due to competition for these resource, obtainability as a bedding material has decreased, while the price has gradually increased. Therefore, it is important to seek alternative sources for bedding material to the poultry industry can be sustainable. Oil palm frond stems (OPFS) were utilized as a foodstuff and a bedding material for pet animals in many countries because of its properties thus could be a good litter material for the rearing of chickens. OPFS on the other hand, were the least attractive part of the plantation tree and usually left rotting between the rows of palm trees, mainly for soil conservation, erosion control and benefit of nutrient recycling. The quality of OPFS produced by a plantation each year make these a very promising sources of roughage feed for ruminants and produced on dry matter basic annually during the pruning and replanting operations in the plantation. However, in this preliminary study on utilizer of oil palm frond stems by cutting-shopping machine prior drying as alternative bedding material for rearing into small size of 0.5-1.5 cm. The cutting-chopping of oil palm frond stems fresh was dried under sun air or oven until the moisture reduced arrange 10 to 15 %, respectively. Moreover, it used as the cushion between animal and a floor to compared with other combination of rice husks percentage as bedding materials. The benefit of finding and properties effects of chickens were water absorbent, moisture content, water holding capacity, water release and could reduce ammonia emission equally. In addition, bedding conditions significantly influence on performance of chicken and the good profit of growers and integrators.

The aims of this study was focused on effect to cover value-add of different sources of bedding material to production welfare and improved reaching of others producers on the growth performance, carcass characteristics and effects of variously an incidence of foot pad dermatitis on broiler chickens.

1.2 Research objectives

1.2.1 To compare the effects of different utilizer on bedding materials with RH, OPFS and ratio to achieve optimum on growth performance, carcass characteristics, and dermatitis in broiler chickens

1.2.2 To compare the effects of bedding material and stocking density to rearing condition influence the occurrence and severity of footpad dermatitis on broiler chickens

CHAPTER II
REVIEW OF LETERATURE

According to several studies, animal husbandry techniques have been developed to ensure the safety of chicken growth. Also, poultry production has many different features, such as semi-management control and raising in the technical evaporation system house. In addition, as poultry production has a variety of characteristics, such as raising in the technical evaporation system, which is used with litter materials on floor for helps to reduce the moisture content, emitted waste from animals, and the temperature given to chickens. Moreover, flocking density of broiler chicken was important for chicken's health. Stocking density can contribute to reduced performance due to a number of factors. Other factors associated with high stocking density that may contribute to poor air quality due to inadequate air exchange, increased ammonia and reduced access to feed and water.

2.1 Housing and ventilation of chicken

Ventilation is commonly mean of controlling on bird environment. Ventilation maintains acceptable air fresh in the house while rearing birds within their comfort temperature. Ventilation provides the air quality, release excess moisture and control the limits of the build-up of potentially harmful gasses and airborne by-products. In addition, most importantly design and management of shed and ventilation are for litter material conditions because the shed temperature, humidity, and air flow. A pair of the vent on the roof of the poultry house will help to remove the hot air. Many studied that exposure to in shed relative humidity of 60 % to75 % were sufficient to wet litter (Dunlop *et al.,* 2016b; FAWC, 2013). Control on shed relative humidity reduces water absorption by litter material and also reduces drips of water that condenses faces. Further, the variable associated with the design of meat chicken shed that contributed to wet litter was side ventilation showed in Figure 2.1.

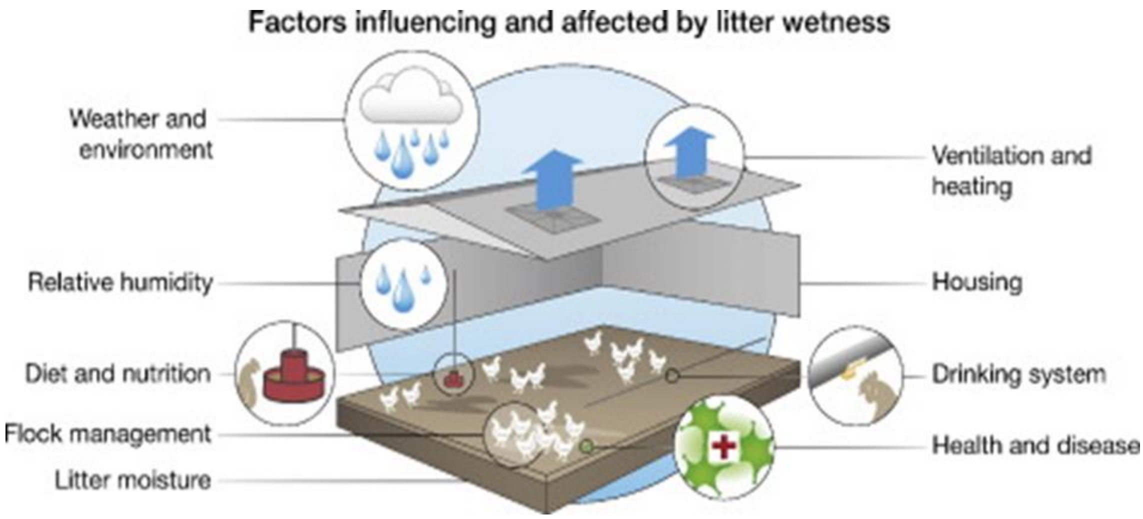

Figure 2.1 Factors influenced and affected by litter wetness
Sources: Dunlop *et al.* (2016b)

Therefore, amount of ventilation was important, but the effectiveness of the ventilation system for brings fresh air inside the poultry house. The conditioning increase moisture-holding capacity and then getting that air to the litter material can dry evenly. Thus many housing and ventilating factors that can affect litter moisture and consider that shed on different farms likely to be different but not likely meaningful and specific solution litter *(*Dunlop *et al.*, 2016b).

2.2 Chicken rearing indoor on litter materials

For successful chicken breeding and obtaining production that wants trash management, it was important. Usually, the litter used for covering the floor of poultry housing system. The litter has described many conditions from fresh bedding material until after it was taken from meat chicken. The bedding material was used to describe the original material applied at the initialing of the litter use cycle during a grow-out period time reared (Dunlop *et al.*, 2016b). Rice husk and wood shaving are common items that farmers around the world used. Alternatively, some other composting materials may be used for purposes such as sand, newspaper, chopped pine straw, peanut hulls, and so on. In contrast, bedding material was used to describe the mixture of bedding plus the manure, feed, feathers and water (Taherparvar *et al.*, 2016). The properties of bedding material change with the accumulation of manure and data collected on bedding material may not be applied throughout a grow-out period. The characteristics of the original bedding can be sustained throughout the life of the blanket. Therefore, litter is used on the floor of meat chicken sheds to absorb moisture, excreta and provide insulation and cushioning from the earth. Moreover, the benefit of bedding material was too absorbed moisture, to release moisture and change diurnally, temporally, spatially during raising chicken. For example, lower litter moisture levels were produced less ammonia into the atmosphere, which helped reduce respiratory stress. High humidity in litter was extremely harmful to poultry health. Wet waste causes problems such as sores and pests on birds, livestock, and produce ammonia gas that hinder poultry production.

Environmental and management factors that contribute to wet litter material were multidimensional and had reasonably well documented in the paper. The various factors that contribute to wet litter are rising damp on the floor, lacking wall and drinker spillage, stocking density, diet and nutrition, relative humidity, litter moisture content or water holding capacity and insufficient litter depth (Dunlop *et al.*, 2016b; Shepherd and Fairchild, 2010).

2.3 The quality and factors influence of bedding material on chickens rearing

Many studies reported that litter materials can be utilized as bedding for broiler chickens rearing. Due to the quality and factors influence were shown in Table 2.1. An ideal litter substrate should not only be able to absorb excess the moisture of feces and spilled water from the drinkers but should be released moisture quickly. Water holding and water releasing capacity are thus important characteristics in the evaluation of litter materials. Characteristics of litter material were various kind period raising on chickens.

Table 2.1 Pre criteria treatments of characteristics of different types on bedding material (42 days)

Litter materials	pH values	Bulk density (kg/m^3)	Moisture content (%)	WHC (%)	WRC (%)	Nitrogen (%)	Ammonia mg/100g	References
Rice husk	5.98-8.5	108.4-230	4.98-34.5	116.7	6.03-26.4	0.18- 3.55	7.8	Farhadi (2014), Garces *et al.* (2013), Miles *et al.* (2011), Monira et al. (2003), Sarica and Cam (2000)
wheat straw	6.17	55.19	5.02-20.87	290.24	3.96	0.39- 2.35	-	Farhadi, (2014), Monira et al. (2003)
wood shaving	5.01-8.9	94.58-317.8	7.03- 33.3	141.3	4.97	0.01	7.0	Farhadi (2014), Tercic *et al.* (2015), Miles *et al.* (2011), Gareces *et al.* (2013)
Sawdust	4.6	182.51	7.44-25.54	283.35	2.3	0.01-3.04	-	Farhadi (2014), Monira *et al.* (2003), Sarica and Cam (2000)
Coconut husk	5.6-8.9	57-227	50.0	2.74	20.7	-	7.6	Bilgili *et al.* (2009) Garces *et al.* (2013)
Newspaper	7.9-90	53-137	25.7	2.97	16.3	-	15.7	Garces *et al.* (2013)
Sugarcane peat	7.26	63.48	57.67	548.14	1.75	0.34	-	Farhadi (2014)
Grass	7.2-9.1	49-133	30.8	-	-	-	21.2	Garces *et al.* (2013)
Corn cob	5.9-9.0	215-359	24.0	3.06	11.0-21.5	-	11.1	Garces *et al.* (2013), Bilgili *et al.* (2009)
Chopped straw	-	368.5	21.93	56.84	-	-	-	Tercic *et al.* (2015)
Sand	5.64-9.0	1087-1500	0.1-7.2	0.28	-	-	24	Garces *et al.* (2013), Miles *et al.* (2011), Bilgili *et al.* (2009)
Sugarcane bagasse	6.93	46.28	30.24-41.07	348.15	3.34	0.27-2.52	-	Farhadi (2014), Monira *et al.* (2003)

2.3.1 Factors effect of bedding material rearing

Poor bedding quality is a major cause of the infection of the skin, footpad dermatitis and lymph nodes in the lymph nodes of breast of chicken rearing. The best way to prevent footprints was to maintain good litter quality by keeping the trash dry and friable. Therefore, the maintenance of good litter quality is not only an effect to the bird, but also to the producer (Aviagen, 2014). Many factors that could be involved in litter quality including bedding material, bedding management and quantity and water drinker management. Every effort should be made to keep litter in good condition to minimize carcass downgrading in Figure 2.2.

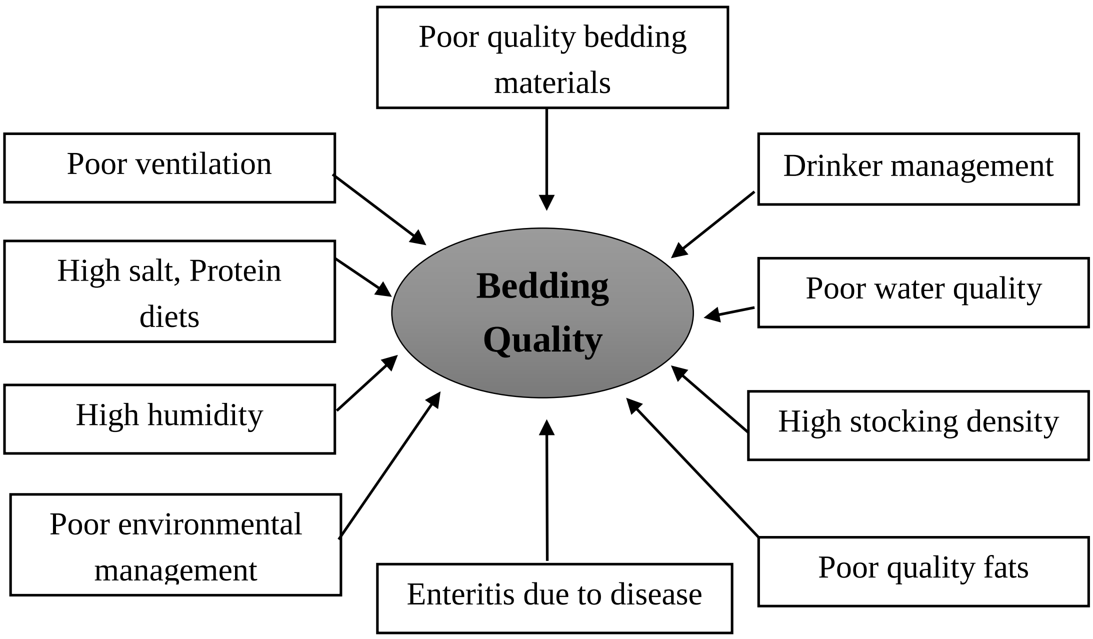

Figure 2.2 Show reasons of poor bedding quality

Sources: Parkhurst and Mountney (1988)

2.3.2 Moisture content of bedding materials

There were a range of different bedding materials available for use in the broiler house. Decisions on which bedding material to use should be based on availability and sustainability of supply. The function of good bedding materials should be:

1) Absorbs excess moisture, habits and improves drying by increasing the surface of the ground floor.

2) Dilutes fecal material due to the reduction of exposure between chickens and manure.

3) Insulates chicks from the freezing effect of the aground and provide a protective pillow between chickens and floors.

Many products are used as bedding material. Regardless of the materials used, it should absorb cheap water, easy to find and not cause problems for birds or for manure (Parkhurst and Mountney, 1988). The quality and quantity of bedding materials can vary greatly from one region to another. It is important that the litter is stored in dry and easy conditions of pets. If the litter becomes caked or too wet (> 50 percent moisture) the incidence of hock burn and breast necrosis will increase substantially.

In poultry many factors affect the whole moisture content. For instance, if new bedding material is not stored properly and becomes damp before it is spread in the broiler house, it may be difficult to avoid wet litter problems. Nutrition also influences litter quality. Certain dietary ingredients (especially salts), when fed in excess, cause broilers to consume and excrete large amounts of water and result in wet litter conditions (Lacy, 2002). Environmental conditions, such as humid wet or cold temperatures, can cause crushing if the air ventilation system does not effectively eradicate moisture. Waterers, foggers and evaporative cooling pads, if not managed and maintained carefully, can contribute greatly to wet litter problems.

2.3.3 Ammonia production (NH_3)

Broilers cannot performed to their genetic potential in a poor environment. Dust was a big especial problem in bedding material like sawdust or fine grinded chopped wheat straw or hay. The factor that influences bedding material conditions the most is moisture. Excess moisture in the bedding material increases the incidence of breast blisters, skin burns, scabby areas, bruising, condemnations and 9 downgrades. Wet drying is also the main cause of the heavily impacted ecosystem, which affects the production of chickens as a result of excessive ammonia production (Lacy, 2002).

Ammonia emission in broiler houses was formed by the breakdown of uric acid by bacteria in the poultry litter. High ammonia emits have been proven to cause increased susceptibility to Newcastle disease, as well as depressing growth rates while allowing *E.coli* organisms to proliferate (Garces *et al.,* 2013). Prolonged exposure to high levels between 50 to 100 ppm is the cause of blindness observed in some broiler flocks reared (Lacy, 2002). When levels are as high as this, production is seriously affected. Ammonia levels of just 25 ppm in house had found to depress growth and increase feed conversion in broilers. Poultry litter moisture is an approach to controlling ammonia levels since litters from 21% to 25% moisture levels make little ammonia. When poultry litter moisture exceeds 30 percent, ammonia production starts and increases as temperature goes up. Bagley and Evans (1998) stated that ideally poultry litter moisture should be preserved at 12 to 25 percent. The rule of thumb in estimating litter moisture content is to squeeze a handful of litter. If it adheres in a ball, it is too wet. If it adheres slightly, it has the proper moisture content. If it will not adhere at all, it may be too dry. However, litter can become seeded with pathogens that affects broiler performance. Obviously, high humidity and high pH levels approval the propagation of pathogens in the litter and there is the proof that these may reason increased mortality rate are reared in the flocks (Lacy, 2002).

2.3.4 Bedding management and quantity

Lacy (2002) and Jordaan (2004) have a series of checklists to consider regarding garbage management:

1. Immediately increase the airflow if you have ammonia.
2. Use a fan to move the air in the house.
3. The combination of heat and ventilation absorbs considerable moisture from the home.
4. Review and repair the water leak. Do not let water on the garbage.
5. Make sure there is no external moisture. Good drainage around the house is very important.

It is likely that the complete cleansing and spreading of new litter between animals is economical. At least it is a good practice to wash and put new compounds at the end of the house. Bedding material should be carefully managed and kept in good condition, whether new or used. The quality of the litter is a concern in maintaining and maintaining materials that will help increase the production of healthy, high-efficiency chickens and, as a result, increase profits for growers and integrators to preserve the environment's thinking for poultry producers. There is a potential return of major dividends.

2.3.5 Bedding materials depth for rearing

There are many different authors used and recommend different depths of floor shown in Table 2.2. Where carcass quality is at a premium, a depth of 10 cm would be beneficial. If the bedding is spread to deep, the birds will have problems moving about (> 10 cm) (Ross Broiler Management manual, 1996).

Table 2.2 Quality of bedding materials depth

Depth (cm)	Qualifications	Reference:
5	Not advised and not provided adequate insulation from cold house floors	Cilliers (1995) and Swain and Sundaram (2000)
5-10	Beneficial in providing greater insulation in these conditions house, even where extended preheating is provided	Ross Broiler Management Manual (1996)
5-10	Adequate litter depth also increased condensation of levels from the house floor	Lohmann Broiler Management Program (1990)
7.5-10	Regardless of the materials used, it should absorb cheap water, easy to find and not cause problems for birds or for manure	Parkhurst and Mountney (1988)

2.4 Flock density management of chicken

Stocking density is normally a significant factor in broiler growth performance. Overstocking increases the environmental pressures on the broiler compromises bird welfare and will reduced profitability. Shepherd and Fairchild (2010) investigation of broiler production that flocks stocked at a higher density (0.48 m^2/ bird) had 10 % more hock lesions and 20 % more breast lesions when compared with flocks at a lower stocking density (0.15 m^2/bird). Higher stocking densities were associated with increased inflammation of the footpad dermatitis compared to a low stocking density (Meluzzi *et al*., 2008). While other studies have shown that stocking density plays off or does not have a role in the formation of foot lesions. Buijs *et al.* (2009) who found that footpad dermatitis was counteractively affected when density reached 56 kg/m^2, While, Dawkins *et al.* (2004) reported that the disease some leg health were composition above a stocking density of 42 kg/m^2. The onset of premature bedding condition impairment associated with high stocking density is considered to affect the progression of the degree of mucous membrane inflammation. Bessei (2006) indicated that bedding materials action deteriorates promptly and bedding material moisture increases as stocking density.

The raising chicken in house was increased as stocking density, water consumption increased from the bird (Feddes *et al.*, 2002). Duration of raising chicken drinks more water, their litter feces may become watery, and thus supply to overall litter moisture. However, although there are many chickens in the house making waste quality difficult to maintain, it is assumed that the stocking density has the effect of littering as long as the appropriate environmental conditions are maintained (Dawkins *et al.*, 2004). Proper stocking density is crucial to building a chicken growing system, ensuring adequate space for optimal processing. In addition to considering on performance and profitability, the right stock density also has significant health implications. In assessing the density of stocks, certain factors, such as housing, air pollution, weight gain and welfare regulations, must be taken into account. An incorrect stock value can lead to problems with redness, rash and death. In addition, the integrity of the litter will be facilitated.

Reducing part of the herd is one way to maintain the best bird density. In some countries, large numbers of birds are the place in housed and targeted for two different weight goals. At the 20-50 % low weight target of the poultry is removed to meet the market demand (COBB, 2013). The remaining birds have plenty of space and are overweight. Various stock densities are employed around the world. In temperate areas, a density of 30 kg/m^2 was closed to good (Table 2.3).

Table 2.3 Effect of stocking density on broiler body weight

Stocking density	Body weight	Ventilation Type
maximum stocking density with 30 kg/m^2	2.50 kg/b	Natural[a]
maximum stocking density with 33 kg/m^2	2.75 kg/b	Positive Pressure[a]
maximum stocking density with 35 kg/m^2	2.91 kg/b	Cross Ventilation[c]
maximum stocking density with 39 kg/m^2	3.25 kg/b	Tunnel Ventilation[b]
maximum stocking density with 42 kg/m^2	3.50 kg/b	Tunnel Ventilation[b]

12 chickens per square meter

Sources: [a]Aviagen (2014); [b]COBB (2013); [c]Dawkins *et al*. (2004)

2.5 Effects of bedding materials on chicken rearing

Based on bedding materials are the base and original litter materials, free the manure that is used at the initialing of the litter cycle and may also be used as a supplement during a grow out period or finished of a rearing period increase to improve litter properties (Dunlop *et al*., 2016a). The appropriateness of the variety of bedding material for muscle chicken production has been investigated and has the ability to maintain humidity, dryness, strong compression, maximum density, particle size distribution, physical properties, contributing to bird health, growth, production and animal properties, or effects on ammonia, friability and caking (Dunlop *et al*., 2016a; Garces *et al*., 2013).

The general practice of management is to remove the debris between animals, provide a waterproofing and better air quality for the animals. In addition, the difference in the particle size of the mattress materials is suggested to be the most important factor. Particle size of bedding materials also contributes to the creation of bread with more than 2.5 cm fragments accelerated because the waste particles tend to bridges. Many factors, including airborne density, creativity, and creativity, can affect the moisture as previous estimates of slime moisture are crucial to the onset of dermatitis (Shepherd and Fairchild, 2010). Particle sizes of litter materials are examined as a contributing factor in the development of foot pad dermatitis and particle size was significantly different between the particles of litter.

Because of bedding moisture is a property that usually measured with rubbish and mattress materials. The maintenance is required when moisture content used to compare water holding capacity of different bedding and waste materials. For example, both pine sawdust and peanut hulls had a moisture content at saturation of 67 %, but had dry bulk densities of 211 kg/m^3 and 96 kg/m^3, respectively. While the moisture content is the same, the water capacity per square meter of litter on the floor (in assuming a 5 cm depth) could be calculated to be 21.4 L/m^2 for pine sawdust and 9.7 L/m^2 for peanut hulls (Dunlop *et al*., 2016b). Friability is an important bedding material because it is influenced by the way that the bird reacts with the litter and delivers dry debris. It was suggested that the capacity of the flow and the variation should be regarded as similar to the way in which each piece of waste is stored together and outside forces need to overcome the intermediate atomic particles.

2.5.1 Effects of bedding material on growth of broiler chickens

Bedding availability issue is rising rapidly in the broiler industry that may alter the types and quality of bedding available to growers to raise broiler chickens. Bedding material and chickens are directed to contact with litter, the potential impact of bedding on disease and comforted health is the concern. The main content of the bedding materials will utilization on the broiler chicken. There were many studied effect of bedding materials on the floor is absorbent moisture, dropping to control reasonably dry and to ensure comfortable condition for chicken sleeping. Many studied of effected by different bedding materials on growth performance showed in Table 2.4.

Table 2.4 Growth performance of broiler rearing on different bedding materials

Bedding types	Growth performance				Reference
	Body weight gain (g)	Feed consumption (g)	FCR	Mortality (%)	
Rice husks	1071±24.9	2626±43.4	2.50	-	Swain and Sundaram (2000) rearing period 42 days
Sawdust	1086±20.2	2789±64.5	2.57	-	
Coir dust	1050±13.6	2711±56.7	2.58	-	
Sawdust	1709	4373	2.56	-	Monira *et al.* (2003) rearing period 49 days
Rich husks	1602	4031	2.52	-	
Sugarcane bagasse	1610	4081	2.53	-	
Wheat straw	1628	4169	2.56	-	
Sawdust	1821.25[a]	3851.50[a]	2.11[a]	0[a]	Hafeez *et al.* (2009) rearing period 35 days
Sand	1823.06[a]	3835.50[a]	2.10a	5[a]	
Wheat straw	1775.00[a]	3813.25[a]	2.15[a]	0[a]	
Rice hulls	1432[ab]	2524[ab]	1.76	-	Huang *et al.* (2009) rearing period 35 days
Wood shavings	1386[b]	2485[b]	1.79	-	
Coconut hulls	1454[a]	2556[a]	1.76	-	
No litter	2129[a]	84.2[a]	1.70[a]	2.4[a]	Toghyani *et al.* (2010) rearing period 42 days
Wood shavings	2091[a]	82.3[ab]	1.69[a]	2[a]	
Rice hulls	2017[b]	78.9[b]	169[a]	2.8[a]	
Paper roll	2072[a]	82.1[ab]	1.71[a]	2.3[a]	
Sand	2116[a]	83.1[ab]	1.69[a]	1.8[a]	
Paddy husks	1930.47±7.83	3623.47±28.15	1.88	-	Sharma *et at.* (2015) rearing period 42 days
Paddy straw	1895.33±5.34	3604.33±32.66	1.90	-	
Pine leaves	1917.43±9.43	3607.65±33.48	1.88	-	
Paddy straw + pine leaves	1848.93±4.38	3588.63±26.86	1.94	-	

[a,b] Mean within the row superscripts differ indicate significant difference (P<0.05)

Sources: Swain and Sundaram (2000); Monira *et al.* (2003); Hafeez *et al.* (2009); Huang *et al.* (2009); Toghyani *et al.* (2010); Sharma *et at.* (2015).

2.5.2 Effects of bedding on carcass characteristics

When dress weight, either of a whole chicken or a cut-up portion, chickens the most important economic criterion to the poultry industry associated factors such as carcass yield, amount of meat and the proportion of meat in relation to live body weight would be of great important to all the parties involved the producer. Poultry refers to the edible flesh, with adhering bones, of any bird that is commonly used as food. On the other hand, poultry can be segmented by cutting through the soft natural joints of the bird such as breast meat, thigh, drumstick, leg, wing, back and neck, and internal organs, liver, heart, gizzard, and spleen. Furthermore, Aviagen

(2014) obtained that carcass yield of the major portions change with increased live weight. In poultry, there were many authors studied factors that affected of bedding materials on carcass characteristics. Toghyani *et al.* (2010) evaluated that five different types bedding materials (no litter, wood shaving, rice hulls, paper roll, and sand) were a significant effected percentage of proventriculus to live weight and not found significantly affect for dressing abdominal fat, gizzard, intestine and ceca. In addition to Bilgili *et al.* (1999) reported that sand and pine shaving using are not any affecting the chill carcass grad, deboning yield, and gizzard. However, Shao *et al.* (2015) found that live weight, carcass weight, heart weight, liver, gizzard weight, and carcass yield were obtained with pine shaving. There were significantly higher than straw and mix form. Table 2.5 showed different type of bedding material that effect on carcass trait at the end experiment.

Table 2.5 Effect of litter types on carcasses trait of broiler chickens

Bedding types	Carcasses trait (%)					Reference:
	Carcass	Liver	Spleen	Gizzard	Heart	
Straw	68.10±0.07	2.46	-	2.37	0.68	Demirulus et al.(2006) rearing period 42 days
Pine shaving	66.63±0.01	2.16	-	1.28	0.68	
Mixed form	67.36±2.85	2.30	-	2.18	0.68	
No litter	76.6	0.309	0.146	2.14	-	Toghyani *et al.* (2010) rearing period 42 days
Wood shaving	75.9	0.337	0.147	2.42	-	
Rice hulls	76.3	0.311	0.177	2.25	-	
Paper roll	75.6	0.359	0.152	2.36	-	
Sand	75.5	0.354	0.185	2.35	-	
Wood shaving	75.21±.25	2.35±.20	0.13±.01	3.15±.33	0.56±.08	Ramadan and El-Khloya (2017), rearing period 42 days
Rice straw	73.29±.34	2.41±.12	0.14±.01	3.06±.56	0.64±.05	
Rice straw +sand	76.65±.40	2.40±.22	0.12±.00	2.85±.30	0.69±.11	
Corn stalks straw	77.12±.58	2.45±.08	0.14±.00	3.43±.40	0.75±.17	
Rice hulls	71.79±.28	2.39±.26	0.13±.01	2.89±.56	0.54±.04	

Means with a column with common not differ significantly

2.5.3 Effects of bedding on footpad dermatitis

Footpad dermatitis (FPD) could be a significant welfare issue for the broiler industry and had financial implications for business who sell feet. Litter quality, nutrition, and enteric health are key to the prevention of feet lesions.

The footpad was the development of dermatitis on the foot of broiler chicken, but it may develop in any area of the foot that contact with the floor

(Aviagen, 2008). In the early stages, footpad shows itself as small erosions and discoloration of the skin. These can develop into painful ulcers, but if corrective action was taken and litter conditions to improve these erosions can heal. It was preferable to prevent rather than cure occurrence of footpad dermatitis. Several considerable factors had confederated with occurrences of contact dermatitis including types, depth, and condition of litter, stocking density, feed composition, light and climate (Tercic *et al*., 2015). Due to contact dermatitis affects skin surfaces that had prolonged contact with wet litter as well as ammonia in a poorly managed bedding (Rastislav, 2014). The condition was manifested as blackened skin progressing to erosions and fibrosis on the lower surface of the foot pad, at the back of the hocks in the breast area in Figure 2.3.

Figure 2.3 Footpad dermatitis scoring for in use broiler chickens

Sources: Michel *et al*. (2012)

Moreover, Meluzzi *et al.* (2008) found that broiler reared on deeper bedding had lower occurrences of footpad dermatitis than reared on a thin layer. The cause of FPD was one of the means from litter quality. So an increment of bedding depth was found on perform lower hock burn score with all centimeter increment by depth, there was decreased in hock burn score of 0.015 points (Haslam *et al.*, 2007 and Shepherd and Fairchild, 2009). There were more many systems in the house that mark bird on the lesion scale of 0 to 5 that accorded to the strictness and abundance of FPD. Moreover, the problem of contact dermatitis was more prominent in birds with a higher incidence of lameness as lame birds spend more time laying on a wet litter. The occurrence of contact dermatitis globally in a closed intensively managed systems according to studies carried out 10 years ago vary from 20 – 40 % (Rastislav, 2014).

2.6 Advantages and disadvantages of various bedding materials

2.6.1 Rice husks

Rice husks is the families of non-wood bio fibers and rice straw is an agricultural production residue whereas rice husk, obtained off-field, was an agricultural developing residue (Bassyouni and Hasan, 2015). The surface of rice husks has corresponded to a protected shell of the rice grain and highly limited as waste litter materials to use as a bedding (Chabannes *et al.*, 2014). Most of this rice husk is either used as a bedding material for animals or discarded in lead completing or controlling to air and soil pollution (Rosa *et al.*, 2012). Therefore, rice husk can manufacture of thermoplastic poly-lignocellulose flour composites is attracting attention by potential biomass energy (Kim *et al.*, 2004).

Generally, compositions of rice husk in percent of weight (dry basis) based on the ultimate analysis. The physical and chemical properties of rice husk ash are dependent on the components of the combustion process, such as combustion type, feeding type, temperature, residence time, and availability of oxygen (aerobic or anaerobic) in Table 2.6.

Table 2.6 The major components of rice husks

Component of rice husk	Percentage (%)
Cellulose	25-35%
Hemicelluloses	18-21%
Lignin	26-31%
Silaca	15-17%
Ash content	17-26%
Moisture content	7.5%
Bulk density	86-114 kg/m³

Sources: Ludueña *et al*. (2011); Rosa *et al*. (2012); Mansaray and Ghaly (1996)

On the other hand, rice husk is the most popular and high cost of all of the material used and the best signification litter material to rearing broiler chickens with help growth better, food consumption and food conversion (Swain and Sundaram, 2000). As consequence of this, it is very important to control the potassium content in the bed, so that any conceivable problem of the bed as sintering could be avoided. The occurrence of temperature gradients in the bed and the presence of large fluctuation of the bed pressure often indicate the beginning of agglomeration in the fluidized bed (Armesto *et al.,* 2002). In additional, rice husks basically fall into the same category in that they work well and are readily available in certain areas of the country and rice husks can be mixed with others litter materials such as pine shavings, wood shavings or can use alone (Grimes *et al.,* 2002). This rice husk has a granular consistency and is mostly silicon dioxide (60 %) and carbon (35 %). However, there was no problem with carcass quality as all of the black bedding material was changed when processing. As with the timber industry and pine shavings, the rice industry is finding more profitable avenues for rice husks other than use as poultry litter (Grimes *et al.,* 2002).

2.6.2 Oil palm frond stems

Oil palm plant is originating the primary export of some West Africa countries and originally cover the other country in Asian (Hartley, 1977). The Asian country, oil palm fronds was an important abundant crop of Malaysia and others countries (Zahari *et al*., 2004). Generally, the oil palm plant is product of oil palm plantation and these include oil palm frond, oil palm trunk (OPT), palm kernel cake (PKC), empty fruit bunches (EFB), palm oil mill effluent (POME), and palm press fiber (PPF) (Wong *et al*., 2003) and nutritive value of oil palm frond is created up of three main components such as a petiole (stem), rachis and leaflets (Figure 2.4) (Mohideen *et al*., 2011).

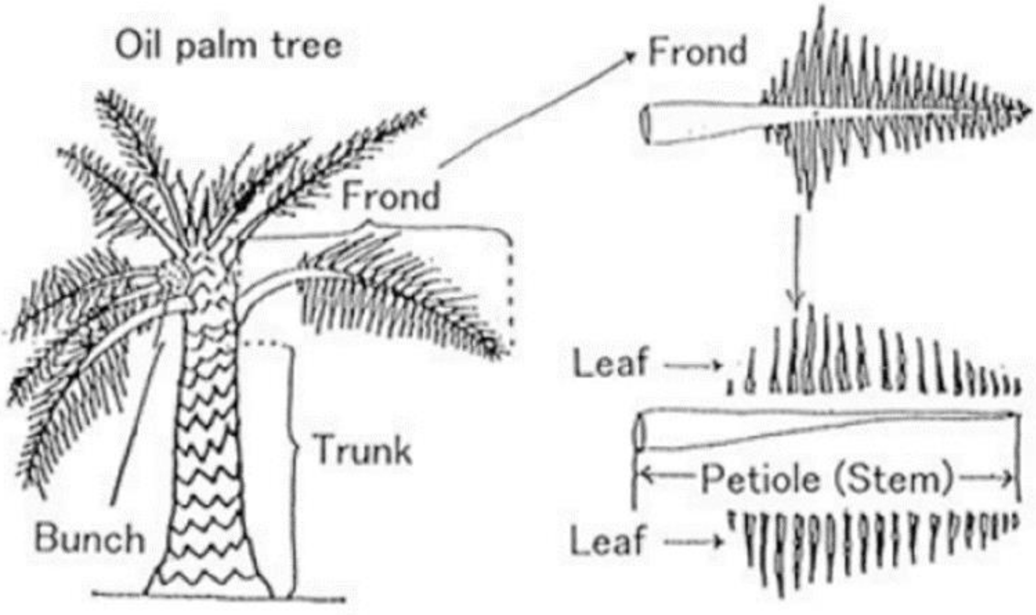

Figure 2.4 Anatomy of an oil palm tree and oil palm frond (OPF)
Source: Mohideen *et al*. (2011)

The dry matter in the OPF about 70 % is from the petiole and another part from leaves and rachis (Wong *et al.*, 2003). The OPF has also contained hemicelluloses about 18.5 % and moisture contents of chopped fresh OPF, solar chopped OPF, OPF which consists of stem moisture content and OPF pellet were 58.6, 44.6, 12.7 and 14.7, respectively density value were 0.27, 0.08, 0.12 and 0.53. The chemical composition of fresh OPF is shown in Table 2.7. Therefore, Oil palm fronds are obtained during harvesting or pruning and felling of palms for replanting and several processing techniques have been used to improve the feeding values of

OPF used by local farmers for feeding beef and dairy cattle in Malaysia (Mohamed and Farid, 2011).

Table 2.7 Composition of oil palm frond

Component of oil palm frond	Percentage (%)
Dry matter of OPF	70%
Ash content	3.2%
Hemicellulose	18.5%
Crude protein	4.7%
Crude fiber	38.5%
Calcium	0.21%
Neutral detergent fiber	78.7%
Acid detergent fiber	55.6%
Ether extract	2.1%
Metabolisable energy	5.65%

Sources: Wong *et al*. (2003); Zahari *et al*. (2004); Karim and Sudin (2015)

In southern province Thailand, oil palm plant is the most popular produced tree for making the oil after rubber tree and based diets for the cattle and dairy production to farmer and industry. Therefore, Papong *et al*. (2010) who recorded high prices of crude oil and environmental concerns have driven the Thai government to set its national energy policy with an emphasis on renewable energy such as biodiesel and bioethanol in order to reduce fossil fuel consumption and to increase the energy security of the country. Besides, from 1 February 2008, the Ministry of Energy has forced a mandatory measure on “B2” biodiesel (2 % of B100) instead of conventional diesel fuel effective. After feed for rearing cattle oil palm plant in Thailand is the most important for biomass sources which have high potential as a renewable energy source for biodiesel (B100 or palm oil methyl ester, PME) production (Papong *et al*., 2010).

CHAPTER III
MATERIALS AND METHODS

In this study, there were two experiments conducted, the first experiment was to determine the effects of litter material as bedding on growth performance, carcass characteristics, and footpad dermatitis of broiler chicken with 5 groups of treatment. The bedding for the T1 group was 100 % rice husks, for the T2 group, it was 75 %:25 % rice husks and oil palm frond stems, for the T3, it was 50 %:50 % of rice husks and oil palm frond stems, for the T4 group, it was 25 %:75 % of rice husks and oil palm frond stems and for the T5, it was 100 % of oil palm frond stems. The second experiment was to determine the effects several of bedding material and stocking densities on broiler chickens in performance, carcass characteristic, and the severity footpad dermatitis score. These experiments were conducted at Poultry Farm, Animal Science Department, Faculty of Natural Resources, Prince of Songkla University, Thailand. All the broiler chickens were reared in the same house under identical environmental conditions.

Oil palm frond stems (OPFS) were a cutting-chopping machine in the small size from 0.5−1.5 cm. OPFS was fresh with a dry matter 70 % and after dried under the sun air dry 7 days or more than, moisture has remained respectively 10 %−15 %.

Figure 3.5 Oil palm frond stems chopping by Cutting-Machine

(a) Oil palm frond stem (Petiole), (b) Oil palm frond stems chopping

Key performance parameters

Calculated using the following equation:

Weight gain (WG)

$$\text{Weight gain} = \text{Final body weight} - \text{Start body weight} \tag{1}$$

Average daily gain (ADG)

Average daily gain = Body weight gain/ age in days chicken (2)

Feed intake (FI)

Feed intake = Total feed consumed/ Number of chicken per pen (3)

Feed conversion ratio (FCR)

Feed conversion ratio = Feed intake/ Body weight gain (4)

Mortality

$$\text{Mortality (\%)} = (\text{number of deaths in a given time period } \times 100\%)/ (\text{Total of chicken }) \tag{5}$$

Killing out percentage

$$\text{Killing out percentage (\%)} = (\text{Part of dressing carcass weight}/ (\text{Live body weight }) \times 100\%) \tag{6}$$

3.1 Experiment 1: Effects of different bedding on growth performance, carcass characteristics, and dermatitis in broiler chicken

3.1.1 Bedding materials and experiment design

Bedding materials were divided into 5 treatments groups. The treatment using in the conducted experiment were applied to different sources of litter material such as rice husks, oil palm frond stems, and ratio bedding. Rice husks litter as long as the particle size was in the ranges of 0.212−0.850 mm used in the sample. Particle size of oil palm frond stems used in the sample was 0.5−1.5 cm. The bedding material of treatments types were:

T1: 100 % rice husks bedding

T2: 75 %:25 % rice husks and oil palm frond stems

T3: 50 %:50 % rice husks and oil palm frond stems

T4: 25 %:75 % rice husks and oil palm frond stems

T5: 100 % oil palm frond stems

3.1.2 Chicken and management design

A number of 360 mixed sex one–day–old broiler chickens (Ross 308) were purchased from the commercial hatchery. Chickens were allocated to 5 treatment material bedding groups in a completely randomized design (CRD) viz. T1, T2, T3, T4, and T5. In each treatment group has 3 replicate pens with 24 chickens per/pen. The room size of bedding materials was 2 m × 1 m with stocking density is 12 chicks/m^2. Chickens feed were purchased from a commercial fed and randomly assigned to groups with similar live body weight. Chickens were kept separately under deep bedding management in a close-sided pen from one day of age and the litter of bedding material was 6.5 cm in depth. Each pen was equipped with a bell drinkers and a tube feeders. Broiler chickens were provided with commercial fed available ad libitum and was formulated into two phases according to starter from 0 to 3 weeks (21 % CP) and a finisher from 4 to 6 weeks (19 % CP) to all chickens in five groups. Lighting will be provided 24 hours daily at 0–21 days of age. The temperature of the pen was maintained at 36 ºC at the beginning experiment and reduced to 28 ºC at 31 days until 42 days of age. Intensive the rearing was applied on litter bedding material from one day of age until 6 weeks of age, then were vaccinated against, Newcastle Disease vaccine (ND), and Infectious Bursal Disease (IBD).

3.2 Experiment 2: Effects of bedding material and stocking density on growth performance, carcass characteristic and incidence of footpad dermatitis

3.2.1 Bedding materials and experiment design

Three different types bedding material were selected from experiment 1 that had effect on growth performance and physicochemical properties period rearing. Bedding materials were conducted to observe growth performance and incidence of lesion score and the problem of bedding characteristics with stocking density. The incidence of the severity footpad dermatitis score and the problem of bedding characteristic were recorded.

The detail of experiment bedding material were:

T1: 100 % oil palm frond stems

T2: 75:25 % oil palm frond stems and rice husks

T3: 50 %:50 % rice husks and oil palm frond stems

3.2.2 Chicken and management design

A total of 225 males one–day–old broiler chickens (Ross 308) were purchased from the commercial hatchery and selected divided into 3 bedding material treatment groups with 2 stocking densities. Chickens were arranged as 3×2 factorials in the completely randomized design (CRD). Each treatment group was contained into 3 replicates pen and stocking density of 10 and 15 chicks per unit/m^2. The chicken was separately kept under deep bedding management system in a close-sided house from one day of age and the litter of bedding material was 6.5 cm depth of bedding materials. Each treatment pen was equipped with a bell drinkers and a tube feeders. Broiler chickens were provided with commercial fed *ad libitum* and supplied with a starter from 0 to 3 weeks (21 % CP) and a finisher from 4 to 6 weeks (19 % CP) to all chickens in three groups. Warming light was provided 24 hours daily at 0−21 days of age and after that normal light was used throughout the experiment. The temperature of the house was 36 ºC (maximum) at the first day and then gradually decreased to 28 ºC (minimum) when chickens were caught. Intensive the rearing was applied on bedding material from one day of old until 6 weeks of age and then were vaccinated against, Newcastle Disease (ND), and Infectious Bursal Disease (IBD).

3.3 Data collection and data analysis

3.3.1 Physical and chemical properties of bedding materials

Litter samples of bedding materials were collected sixth time from 5 sites (Hoskins *et al.,* 2003) and taken in plastic sheet bag from each replicate every week to determine physicochemical properties for experiment 1 and for experiment 2 were collected three time from 1, 3 and 6 weeks of reared time periods. These properties were moisture contents (MC), water holding capacity (WHC), pH value, bulk density (BD), and ammonia (NH_3).

Moisture contents (MC)

The moisture content of bedding material (MC) was measured after drying sample for approximately 24 h at 105 ºC by using 5 g of sample and calculated formula by the following equation according to Sluiter *et al.*(2008).

$$\mathrm{MC} = 100 - \left(\frac{(\text{Weight dry pan plus dry sample} - \text{Weight dry pan})}{\text{Weight sample as receaved}} \times 100\%\right)$$

Water holding capacity (WHC)

WHC of bedding material was directed determine as suggested by Garces *et al.* (2013). 30 g of each litter sample of bedding materials was placed in a beaker. The beaker was filled with deionize water and stand for 30 minutes. Then excess water was drained for 3 minutes and the sample was weighted gain; the percentage of water absorbed was calculated on a dry meter basis on.

$$\text{WHC (\%)} = \frac{\text{Wet weight} - \text{Sample wieght}}{\text{Sample wieght}} \times 100\%$$

Where:

Wet weight : Mass weight of sample after fill with water (g)

Sample weight : Mass initial weight of sample (g)

pH value

The pH value of bedding material was recorded by using 30g of macerated was added to 250 ml of deionized water, agitated for 5 minutes, and suspended for 30 minutes after by pH meter (Mettler-Toledo).

Bulk density

Bulk density of bedding material was determined by calculating grams of dry sample per cubic centimeter suggested by Bilgili *et al.* (2009). The dry weight of each material was dried for 72 h at 70 ºC. 20g sample of from each material was placed in nylon socks and fully submerges in deionized water for 24 h. At the end of each interval, the socks were hung for air dry for 30 minutes and subsequently reweight.

Ammonia emission (NH_3)

Determination of NH_3 volatilization was based on the spectrophotometer (Spectroquant Prove 300, Merck®) method as the following by NH_3 Test-Kit®. Calculated by the following equation:

$$\mathrm{NH_3}(mg/l) = \frac{\text{Raw data } \times \text{Dilution } \times \text{V. deionizes water}}{\text{Wt sample}}$$

Where;

Raw data	: Data analyze from spectrometer (mg/l)
Dilution	: volume of sample analyze (ml)
V	: Volume of deionizes water (ml)
Wt	: Weight of sample (g)

3.3.2 Growth performance

The data pertaining of parameters on average daily gain (ABW), WG, ADG, FI, FCR and mortality were recorded every week for each pens from 1 to 6 weeks of age.

3.3.3 Carcass characteristics

Carcass characteristics, at the end of the experiment 42 days of age, two chickens that had body weight close to the replication mean were randomly slaughtered for evaluation carcass quality from each replicate pens (30 chicks) for experiment . Experiment 2 were killed 36 chicks for slaughter carcass trait. Chickens were banded and moved out without feed (approximately 6 hours) while ad libitum water was provided. Chickens were slaughtered at a commercial slaughter house. Chickens were determined to eviscerate carcass weight on the breast, pectoralis minor, drumstick, thigh, leg, wing, head and neck, skeletal, liver, gizzard, spleen and abdominal fat. The slaughter yield and eviscerated carcass were calculated to express as a percentage of live body weight.

3.3.4 Footpad dermatitis

The incidence and severity (i.e., extent of lesions) footpad dermatitis were determined collection for using 3 types scoring structure with 5 lesions score followed by Michel *et al.* (2012) when rearing chickens at 28, 35, and 42 days of age of each trial. Data were scored recording to a score scale on footpad lesions in all the chickens. Footpad dermatitis was determined on the base score which 1= no lesion, 2= mild lesion, discoloration of the foot pad, superficial lesions, dark papillae, 3= severe lesion; ulcers or scabs, signs of hemorrhages or swollen footpads, and 4 and 5 = <50 % or >50 % of the footpad.

3.4 Statistical analysis

3.4.1 Experiment 1

The Growth performance, carcass characteristics, footpad dermatitis score and quality of bedding materials data of the experiments were analyzed using randomized design and analysis of variance (ANOVA) in a completely randomized design (CRD) with SAS software version 9 (SAS, 2002). Mean values were determined for the comparable significance of difference with Duncan's multiple range tests.

3.4.2 Experiment 2

Data recorded from experiment two were analyzed using the ANOVA procedure of SAS software version 9 (SAS, 2002) with completely randomized design (CRD) in a 3×2 factorials arrangement of treatments with three bedding materials and two stock densities of broiler chickens (10 and 15 chicks/m^2). Mean values were determined for the comparable significance of difference with Duncan's multiple range tests.

CHAPTER IV
RESULTS AND DISCUSSION

4.1 Experiment 1: Effect of litter material as bedding on the growth performance, carcass characteristics and dermatitis in broiler chicken

4.1.1 Physical and chemical properties of bedding materials in the rearing chicken

The physical and chemical properties include moisture content, Water holding capacity (WHC), pH value, bulk density, and ammonia (NH_3) characteristics of bedding materials used in this study. The examined materials should be able to absorb the moisture and ammonia emission and water from feed content and the bell drinkers, but should also release moisture and reduce ammonia quickly. In these important of characteristics, the assessing of bedding materials was water holding capacity and bulk density. In addition, in the poultry houses, litter often combines a variety of dry and absorbent bedding materials during the reproduction of quality bedding changes due to the addition of excreta, feed, and feathers, and accumulation of wasted feed and water, which are further decomposed by moisture and local microbiota.

Moisture content

The initial moisture contents in all bedding materials were not significantly effect to rearing with broiler chicken showed in Table 4.8 ($P>0.05$). At initial moisture content levels were the lowest in T1 and the highest in T5 ranging from 10.80 % to 12.58 %, respectively. Some factors determine the amount of water absorbed by the bedding material. During 1 week until 6 weeks of age of moisture content to increased gradually with faces of chickens. In contrast, rice husks showed the lowest moisture content values compared with all others bedding material. Of all the bedding materials experiment, T3 showed the highest moisture content ability. Results in this study the bedding materials are acceptable for rearing broiler chicken.

T5 (oil palm frond stems) has been used successfully with the intent of using the litter as a substrate component in production.

Table 4.8 Moisture content at weekly

Treatments	Moisture content (%)						
	Initial	1 week	2 weeks	3 weeks	4 weeks	5 weeks	6 weeks
T1	10.80	29.11	31.40	33.97	37.06	39.85	39.47
T2	11.29	25.58	31.42	35.75	37.91	45.82	47.82
T3	11.08	25.41	26.24	32.97	37.97	48.89	49.24
T4	12.40	25.11	27.09	34.06	36.86	44.18	47.44
T5	12.58	24.35	27.54	34.09	38.97	45.15	46.89
SEM	0.75	3.41	2.90	4.98	4.40	4.44	4.18
P-value	0.053	0.510	0.143	0.971	0.976	0.243	0.106

Means within the column with no common superscripts not differ significantly (P>0.05), T1= 100% rice husks, T2= 75%:25% rice husks and oil palm frond stems, T3= 50%:50% rice husks and oil palm frond stems, T4=25%:75% rice husks and oil palm frond stems, T5= 100% oil palm frond stems.

As shown in Table 4.8, moisture content of T5 and T4 at initial time had a higher comparison with those other treatment (P>0.05). This result was similarly with finding by Farhadi (2014) indicated that bedding materials of sugarcane bagasse and peat had a greater at initial moisture content. The particle size of bedding materials had a necessary due to absorb of moisture content. However during reared 6 weeks, moisture content from all bedding was increased significantly but not wet in agreement with the reported of Brake *et al.* (1993). Due to the highest value of moisture was showed the highest in T3 (49.24 %) and the lowest value was in T1 (39.47 %) (P>0.05), Bilgili *et al*. (2009) found that ground door filler and cotton gin trash showed highest litter moisture retention ability. Also, Farhadi (2014) supported that high moisture content (>50 %) should be reduced before as bedding materials in sugarcane bagasse and peat.

WHC

The substrate heat not only absorbs the moisture of the water that flows from the drinker, but it should also release moisture as soon as possible. Water retention is the main feature of bedding materials rating. At initial until 2 weeks of age, water holding capacity showed significantly different effected of bedding materials ($P<0.05$). Of the bedding materials, T1 (rice husks) had significantly higher and T5 (oil palm frond stems) significantly lower absorptive capacity. However, during broiler chicken had grower from 3 to 6 weeks of age, shown in Table 4.9, all treatments of bedding material were decreased on average of water capacity to loss water throughout the cycle and particle size ($P>0.05$). Lower flows such as holding capacity their condensed particle size and compacting up. Regarding the resulted, it could be inclusion that at initial until 2 weeks, the capacity of water holding had a higher percentage to holding than 3 to 6 weeks of age.

Table 4.9 Water holding capacity at weekly

Treatments	WHC (%)						
	Initial	1 week	2 weeks	3 weeks	4 weeks	5 weeks	6 weeks
T1	31.11^{a}	33.50^{a}	32.66^{a}	27.34	24.96	19.55	15.35
T2	21.68^{b}	29.45^{b}	30.54^{ab}	25.62	21.60	20.38	18.80
T3	20.62^{b}	29.75^{b}	28.55^{bc}	26.79	19.73	19.36	25.77
T4	16.11^{c}	26.99^{b}	28.38^{bc}	22.89	24.23	22.60	20.77
T5	11.15^{d}	28.65^{b}	26.30^{c}	21.65	19.11	18.41	19.58
SEM	2.40	1.97	1.54	3.63	4.62	3.69	4.38
P-value	0.000	0.026	0.005	0.302	0.470	0.704	0.141

^{a,b} Means within the column with no common superscripts differ significantly ($P<0.05$),
T1= 100% rice husks, T2= 75%:25% rice husks and oil palm frond stems, T3= 50%:50% rice husks and oil palm frond stems, T4=25%:75% rice husks and oil palm frond stems, T5= 100% oil palm frond stems.

In this study, water holding capacity showed a higher capacity at initial reared and the end showed a lower for different bedding materials. The results were similar to the value found from Gares *et al.* (2013) on rearing recycle litters and Tercic *et al.* (2015) reported that water holding capacity was increased on chopped straw and wood shaving of broiler. The result was indicated that the WHC value ranged from 15.35 % to 25.77 % for different bedding, respectively ($P>0.05$). It agree with Meluzzi and Sirri 2009 found the similar results, the water holding capacity of litter material was a fundamental factors to consisted of small particles in the moisture content.

pH value

At initial pH value, the highest and lowest were related to T1 (6.29) and T5 (4.51), respectively ($P<0.05$). On average, pH increased gradually from 1 to 6 weeks of age during the rearing period with rice husks and oil palm frond stems (T2) showing the greatest increased and oil palm frond stems (T5) the lowest ($P>0.05$) in Table 4.10. Meanwhile, at 5 weeks of age, pH value was accepted statistically significant affected by different bedding material to chicken ($P<0.05$). T2 and T4 were higher in the pH value of broiler chicken with bedding materials, however, only pH value in T3 was lower of bedding material. It was add advantage, if bedding material has a small pH level and the conversion of uric acid to ammonia was deceased at acidic pH levels. Although pH and ammonia emission in this study were positively correlated of the variation could be enlightened by the association increase.

Table 4.10 pH value at weekly

Treatments	pH value						
	Initial	1 week	2 weeks	3 weeks	4 weeks	5 weeks	6 weeks
T1	6.29^{a}	6.34	7.29	7.81	8.22	8.57^{ab}	8.73
T2	5.66^{b}	6.48	7.45	7.76	7.97	8.68^{a}	8.94
T3	5.01^{c}	6.32	7.38	7.94	8.09	8.32^{b}	8.90
T4	4.97^{cd}	6.23	7.49	7.81	8.07	8.71^{a}	8.89
T5	4.51^{d}	6.05	7.71	7.93	8.10	8.49^{ab}	8.67
SEM	0.23	0.16	0.54	0.50	0.40	0.13	0.24
P-value	0.000	0.080	0.908	0.986	0.957	0.031	0.594

[a,b] Means within the column with no common superscripts differ significantly ($P<0.05$),
T1= 100% rice husks, T2= 75%:25% rice husks and oil palm frond stems, T3= 50%:50% rice husks and oil palm frond stems, T4=25%:75% rice husks and oil palm frond stems, T5= 100% oil palm frond stems.

The observed differences in the pH value may be attributed increasing in the chicken on others bedding materials particularly on T2. The pH highest value was in T2 (8.95) and the lowest value in T5 (8.67). These results were agreement with finding of Gares *et al.* (2013) found pH value that increased 35 % – 57 % on rearing cycle all litters had effects of concentrations of feces and water on over time in bedding material pH level. Coufal *et al.* (2006) reported that wood shaving and sawdust have a pH ranged from 5 – 5.6, whereas rice hulls had a pH around 7.03. It is reported the advantage of bedding materials which were low in pH value because in acidic pH and uric acid to ammonia would be reduced (Moore *et al.*, 1996). Contrary, Farghly (2012) found that pH value of litter was one the most necessary factors to determine the aqueous phase ammonia concentration and therefore influences ammonia release.

Bulk density

At initial bulk density, the highest and lowest were related to T5 (313.97 kg/m^3) and T1 (158.03 kg/m^3), respectively (P<0.05). Bulk density of the bedding materials were gradually increased during period because of the higher moisture and deposition of fecal caking of particle size with litter chickens. Moreover, increased the percentage variation in bulk density from initial to 6 weeks of age, could be an indicated to T1 (64.76 %), T2 (71.70 %), T3 (25.53 %) T4 (20.90 %), and T5 (17.99 %). On the other hand, increased of percentage T2 had the highest bulk density (71.70 %) followed by T5 (17.99 %) in all bedding types accepted in the experiment (Table 4.11).

Table 4.11 Bulk density value rearing at weekly

Treatments	Bulk density (kg/m^3)						
	Initial	1 week	2 weeks	3 weeks	4 weeks	5 weeks	6 weeks
T1	158.03^d	178.73	191.57^d	200.79	212.14	233.94	260.38^c
T2	210.19^c	240.36	250.04^c	265.37	323.27	337.75	360.90^{ab}
T3	258.05^b	269.18	278.69^{bc}	287.21	298.43	316.38	323.95^b
T4	298.49^{ab}	321.26	310.33^{ab}	316.78	323.27	337.75	360.90^{ab}
T5	313.97^a	340.12	329.67^a	356.76	368.21	367.75	370.47^a
SEM	22.28	20.58	23.74	24.71	25.60	32.63	19.57
P-value	0.000	0.228	0.010	0.361	0.747	0.386	0.044

^{a,b} Means within the column with no common superscripts differ significantly (P<0.01), T1= 100% rice husks, T2= 75%:25% rice husks and oil palm frond stems, T3= 50%:50% rice husks and oil palm frond stems, T4=25%:75% rice husks and oil palm frond stems, T5= 100% oil palm frond stems.

The results obtained from this study showed the beginning bulk density bulk density had significantly on reared ranged from 158.03 to 313.97 kg/m^3 and the end were found from 260.38 kg/m^3 to 370.47 kg/m^3 respectively ($P<0.05$). The increased in the bedding materials had a greater properties on build up litter and many commercially available litter treatments reduce ammonia volatilization through production (Tercic *et al.*, 2015). These results were in agreement with Garces *et al.* (2013) and Farhadi (2014) who reported that bulk density had significantly affected by litter type on sawdust and bagasse. Moreover, characteristics of bulk density of bedding materials may be depended on level of moisture content.

Ammonia (NH_3)

Ammonia production is caused by the analysis of bacteria of uric acid in chicken manure. The ammonia emission of different treatment bedding materials showed in Table 4.12. The organic of different type of bedding materials did not detect at initial. Meanwhile, during rearing periods in 1 week up of age showed that emitted ammonia and increased relative from T5 (0.008 mg/kg) to T2 (0.017 mg/kg), respectively ($P>0.05$). At the end of the experiment except the ammonia, all bedding materials were emitted significantly ($P<0.05$) and the highest ammonia in T1 (0.293 mg/kg) compared to the lowest in T4 (0.176 mg/kg.

Table 4.12 Ammonia value at weekly

Treatments	Ammonia (mg/kg)						
	Initial	1 week	2 weeks	3 weeks	4 weeks	5 weeks	6 weeks
T1	-	0.012	0.120^{ab}	0.118	0.131	0.158	0.293^{a}
T2	-	0.017	0.148^{a}	0.079	0.109	0.172	0.237^{ab}
T3	-	0.014	0.061^{bc}	0.073	0.085	0.207	0.228^{ab}
T4	-	0.008	0.050^{c}	0.052	0.118	0.138	0.176^{b}
T5	-	0.008	0.038^{c}	0.091	0.119	0.202	0.274^{a}
SEM	-	0.00	0.03	0.03	0.04	0.04	0.04
P-value	-	0.228	0.010	0.361	0.747	0.386	0.044

^{a,b} Means within the column with no common superscripts differ significantly ($P<0.05$),

T1= 100% rice husks, T2= 75%:25% rice husks and oil palm frond stems, T3= 50%:50% rice husks and oil palm frond stems, T4=25%:75% rice husks and oil palm frond stems, T5= 100% oil palm frond stems.

The result indicated that ammonia emission was detected at initial rearing and it also agreed with Ly *et al.* (2017) because of started rearing of NH_3 found the lowest on oil palm frond stem and rice husk in chicken reared, while Gareces *et al.* (2013) who obtained the ammonia volatilization had lowest from poultry litter can be air pollution and fertilizer value of litter. However, at 6 weeks of age, ammonia was increased relate from 0.176 to 0.293 mg/kg by different bedding material, respectively ($P<0.05$). Similarity, Gareces *et al.* (2013) shown that the presence of emitted significantly of ammonia on sand, grass and newspaper litters rearing and increased gradually. Contrary, Haslam *et al.* (2006) concluded that litter ammonia may be another important factor in the etiology cause of ammonia generated bacterial action dissolves in high moisture litter to create solution for the incidence footpads. Also, Casey *et al.* (2014) found chickens were sensitive to ammonia when exposure to high levels from 50-100 ppm can be blind chicken, respiratory disease and increased condemnations.

4.1.2 Growth performance

There were no statistically differences ($P>0.05$) of the average body weight and weight gain between the different bedding materials (Table 4.13). Meanwhile, the average body weight reflected the percentage of livability weight, the rearing duration and the feed conversion ratio. Body weight tended to be the highest in the T4 (2873.38 g) and the lowest was found of body weight in T2 (2694.04 g).

The results of this study and other numerous studies reported that in alternative bedding rearing did not impact on body weight and in which alternative bedding were observed to indicate that differently used bedding effective on performance of broiler (burke *et al.,* 1993; Grimes *et al.,* 2006; Hafeez *et al.,* 2009). Regarding the resulted, the weight gain from 0 – 3 weeks of age was increased relation in all of the bedding and during 4 – 6 weeks of age, weight gain increased in T4 which are the highest weight gain accepted at the end of the experiment. Also, the result agrees with Fahadi (2014), Mahmoud *et al.* (2014) and Sharma *et al.* (2015) who reported that bedding types have an important effect on body weight gain at 4 – 6 weeks of age and properties could be successfully utilized as alternate poultry bedding with the result.

Table 4.13 Average body weight and weight gain of broiler chicken reared using different bedding materials at weekly

Age (weeks)	T1	T2	T3	T4	T5	SEM	P-value
Initial weight (g)	44.20	44.07	44.09	44.87	44.07	1.13	0.887
Average body weight (g)							
1	168.07	166.13	157.78	165.62	164.13	6.22	0.370
2	436.90	432.27	451.82	450.13	414.44	16.24	0.101
3	895.00	892.98	895.96	891.24	881.87	24.09	0.951
4	1588.44	1548.96	1517.82	1523.42	1556.24	64.91	0.689
5	2168.20	2150.27	2150.78	2205.82	2165.02	85.19	0.925
6	2798.76	2694.04	2812.60	2873.38	2822.33	147.83	0.675
Weight gain (g)							
1	123.87	122.08	113.699	120.76	120.07	6.31	0.379
2	268.69	266.13	294.05	284.51	250.31	16.09	0.055
3	458.24	460.71	444.13	441.11	467.42	12.79	0.128
4	693.44	655.98	621.87	632.18	674.38	64.15	0.650
5	579.76	601.31	632.96	682.40	608.78	74.49	0.535
6	630.56	543.78	661.82	667.56	657.31	90.07	0.461
0-3 weeks	850.80	848.91	851.87	846.38	837.80	24.15	0.952
4-6 weeks	1903.80	1801.10	1916.60	1982.10	1940.50	139.99	0.614
0-6 weeks	2754.60	2648.60	2768.50	2828.50	2778.30	147.77	0.672

[a,b] Means within the row with the differ superscripts are not significantly different (P>0.05), T1= 100% rice husks, T2= 75%:25% rice husks and oil palm frond stems, T3= 50%:50% rice husks and oil palm frond stems, T4=25%:75% rice husks and oil palm frond stems, T5= 100% oil palm frond stems.

Bedding materials used in the experiment did not give significantly different effect on the feed intake and average daily gain inclusion, except the feed intake at 2 weeks of age (Table 4.14). T1, T2, T3 and T4 were higher in the feed intake of broiler fed with bedding materials and lower was T5 ($P<0.05$). over the whole experimental period, average daily gain of broiler in different bedding materials did not differ statistically affected but it found a grower rate in T4 compared to others pens of bedding ($P>0.05$).

Feed intake in different bedding rearing with broiler did not differ significantly. Broiler reared in T5 has the lowest decrease in feed intake whereas reared in T1 have the highest increase feed intake. Ross 308 standard had higher feed intake than the experimental feed (Aviagen 2014). The experiment feeds had lower feed intake than Ross 308 standard about 12.49 %, 14.61 %, 15.69 %, 13.16 % and 15.71 % of T1, T2, T3, T4 and T5, respectively. Moreover, Huang *et al.* (2009) reported that feed intake was a greater on the coconut hull treatment as compared with the wood shavings treatment.

The average daily gain in different bedding materials of broiler reared did not differ statistically different and found a grower in T4 compared to others pens of bedding. Consequently, it also had lower average daily gain than Ross 308 standard (Aviagen 2014) about 5.42 %, 22.25 %, 0.44 %, -0.40 % and 0.01 % for T1, T2, T3, T4 and T5, respectively. Due to lower of feed intake and average daily gain in the experimental maybe caused by the temperature in the house or feed were not encounter suggested specifications for Ross standard. For instance, feed specification of Ross 308 standard was divided by three time, starter, grower and finisher with target balance live weight from 2.5 kg – 3.0 kg.

Table 4.14 Feed intake and AGD of broiler chicken reared using different bedding materials at weekly

Age (weeks)	T1	T2	T3	T4	T5	SEM	P-value
Feed intake (g)							
1	138.49	133.76	131.54	128.42	129.79	3.81	0.062
2	357.40[a]	364.23[a]	357.47[a]	360.47[a]	330.53[b]	12.23	0.045
3	585.01	569.85	567.36	567.90	584.75	22.57	0.744
4	913.15	904.81	904.94	900.88	887.75	39.03	0.948
5	1048.10	1028.15	1005.56	1057.31	1025.42	79.22	0.934
6	1170.49	1133.95	1129.18	1172.77	1137.07	94.49	0.958
0-3 weeks	1080.90	1067.84	1056.38	1056.84	1045.07	28.28	0.616
4-6 weeks	3131.80	3066.90	3039.70	3131.00	3050.20	168.90	0.928
0-6 weeks	4212.70	4134.70	4096.10	4187.70	4095.30	187.30	0.907
ADG (g)							
1	17.69	17.44	16.24	17.25	17.15	0.91	0.410
2	38.38	38.02	42.01	40.65	35.76	2.30	0.055
3	65.46	65.81	63.45	63.01	66.77	1.82	0.128
4	99.06	93.71	88.84	90.31	96.34	9.16	0.650
5	82.82	85.90	90.42	97.49	86.77	10.62	0.531
6	90.08	77.68	94.55	95.36	93.90	12.86	0.461
0-3 weeks	121.54	121.27	121.69	120.91	119.68	3.44	0.952
4-6 weeks	271.96	257.29	273.80	283.16	277.21	19.99	0.614
0-6 weeks	393.51	378.57	391.84	404.07	396.89	21.31	0.688

[a,b] Means within the row with the same letter are not significantly different (P>0.05). T1= 100% rice husks, T2= 75%:25% rice husks and oil palm frond stems, T3= 50%:50% rice husks and oil palm frond stems, T4=25%:75% rice husks and oil palm frond stems, T5= 100% oil palm frond stems.

The results of feed conversion ratio (FCR) and mortality showed in Table 4.15 by different bedding materials. FCR value of broilers reared on T1 and T2 were not significantly different than those reared on T3, T4 and T5 ($P>0.05$). Comparatively more cake information was observed in pens containing T1 and T2. It was observed that higher cake information in T1 and T2 restricted the movement of broiler chicken toward feeders and drinkers water, resulting in high feed consumption and less weight gain as compared to others broiler chicken kept on T3, T4 and T5. Due to statistically there was no different in the five treatment groups. Mortality rate was observed 2.77 % in broiler chickens on T1, T2 and T4, respectively. Meanwhile, it observed that there was no broiler chicken died in pen T3.

The FCR and mortality reared on different bedding were not significantly different and had a similar levels of all treatments reared. Moreover, many researchers had an observed similar findings regarding the influence of various by bedding materials on FCR and mortality (Grimes *et al.*, 2006; Atapattu and Wickramasinghe (2007); Sharma *et al.*, 2015). However, percentage of mortality rate was not affected by treatment bedding and as observed, there was 2.77 % the similarity from T1, T2, T3 and 1.38 % from T5, there was no mortality rate on T3.

Table 4.15 FCR and mortality of broiler chickens reared using different bedding materials at weekly

Age (weeks)	T1	T2	T3	T4	T5	SEM	P-value
FCR							
1	1.12	1.10	1.17	1.06	1.08	0.05	0.215
2	1.33	1.37	1.21	1.26	1.32	0.07	0.182
3	1.28	1.24	1.28	1.29	1.25	0.06	0.881
4	1.34	1.38	1.46	1.43	1.33	0.11	0.547
5	1.83	1.72	1.59	1.56	1.72	0.23	0.642
6	1.87	2.09	1.76	1.77	1.73	0.23	0.375
0-3 weeks	1.27	1.26	1.24	1.25	1.24	0.04	0.906
4-6 weeks	1.65	1.71	1.59	1.58	1.57	0.10	0.469
0-6 weeks	1.53	1.56	1.48	1.48	1.47	0.06	0.383
Mortality (%)	2.77	2.77	0.00	2.77	1.38	2.84	0.689

Means within the row with differ superscripts are not significantly different ($P>0.05$), FCR= feed conversion ratio,
T1= 100% rice husks, T2= 75%:25% rice husks and oil palm frond stems, T3= 50%:50% rice husks and oil palm frond stems, T4=25%:75% rice husks and oil palm frond stems, T5= 100% oil palm frond stems.

4.1.3 Percentage of carcass characteristics and internal organ

Percentage of broilers carcass yield were summarized in Table 4.16. Percentage of carcass yield were not significantly different affected by bedding treatments (P>0.05) on hot carcass and proportion of cut-up parts in breast, pectoralis minor, thigh, drumstick, wings, leg, head and neck, skeletal and abdominal fats. However, percentage of hot carcass and breast were tended the higher in broilers reared on T4 and lower in T1 and T2 (P>0.05). Percentage of pectoralis minor and leg were similar weight of levels in accepted this experiment. Moreover, breast, thigh and drumstick were important to percentage of eviscerated on boiler chicken weight. However, it had a similarity with Ross standard on the breast, thigh and drumstick were ranged 20.22, 13.02 and 9.83, respectively.

As shown in Table 4.16, there was not significantly different affected by bedding treatments (P<0.05). Percentage of hot carcass and breast was highest in T4 and lowest in T1 and T2. Percentage of pectoralis minor and leg were similar weight of levels in accepted this experiment. Thigh showed the highest in T4 and the lowest in T5. Also, at all bedding drumsticks were increased percentage in T2 and decreased low weight low in T3. In this present study, similar to result with Aviagen (2014) observed that the Ross-308 standard on breast, thigh, drumstick and pectoralis minor, wings, leg, head and neck, skeletal and abdominal fats were not significantly different affected by bedding materials.

Table 4.16 Carcass traits (percentage) of broiler chickens reared using different bedding at 6 weeks of age

Treats	Carcass traits (%)										
	Hot Carcass	Eviscerated	Breast	Filet	Thigh	Drum-stick	Wings	Leg	Head & neck	Skeletal	Abdominal fats
T1	89.17	76.87	20.15	3.97	13.05	9.88	7.83	3.39	5.58	18.60	1.54
T2	91.38	75.18	19.32	3.72	13.10	10.35	7.42	3.48	5.15	17.79	1.34
T3	90.08	76.53	20.31	3.93	13.40	9.35	7.82	3.54	4.76	18.17	1.20
T4	93.74	76.36	21.01	3.90	13.45	9.83	7.28	3.50	5.17	17.40	1.58
T5	92.90	74.54	20.31	3.88	12.11	9.74	7.15	3.49	4.81	17.85	1.56
SEM	4.20	1.88	2.20	0.21	0.55	0.42	0.34	0.18	0.57	1.03	0.46
P-value	0.663	0.541	0.781	0.665	0.085	0.147	0.119	0.881	0.449	0.692	0.813

Means within the column with no common superscripts differ significantly (P>0.05),

T1= 100% rice husks, T2= 75%:25% rice husks and oil palm frond stems, T3= 50%:50% rice husks and oil palm frond stems, T4=25%:75% rice husks and oil palm frond stems, T5= 100% oil palm frond stems.

Percentage of internal organs (liver, heart, gizzard, and spleen) were not significantly affected by bedding materials (Table 4.17). Also percentage of hearth and gizzard were tended to decrease in broiler reared on T1, T2 and T4. However, it was observed that increased weigh in T3 and T5. The increased may be from cutting or issue replicate in pens weight of broiler chickens. Spleen was lower in broiler reared on T4 than other bedding inclusion. The value of them were similarity of percentage weight, due to it may be not gave a problem on chicken's health by bedding types.

Table 4.17 Internal organs (percentage) of broiler chickens reared using different bedding at 6 weeks of age

Internal organ	T1	T2	T3	T4	T5	SEM	P-value
Liver	1.65	1.76	1.70	1.79	1.80	0.13	0.641
Heart	0.41	0.41	0.43	0.42	0.42	0.06	0.994
Gizzard	0.94	0.82	1.07	0.94	1.03	0.10	0.106
Spleen	0.09	0.08	0.08	0.06	0.08	0.02	0.725

Means within the row with differ superscripts are not significantly different (P>0.05).
T1= 100% rice husks, T2= 75%:25% rice husks and oil palm frond stems, T3= 50%:50% rice husks and oil palm frond stems, T4=25%:75% rice husks and oil palm frond stems, T5= 100% oil palm frond stems.

The results showed percentage of the internal organs of liver, heart, gizzard, and spleen were not influenced significantly by different bedding materials in Table 4.17. The spleen weight was not significantly lower in chicken reared on T4 than other beddings. A similar to the percentage of liver, heart, gizzard and spleen did not affect any bedding materials on broiler rearing inclusion (Daviv *et al.*, 2010; Ramadan and El-Khloya 2017). However, rice hulls and wood shaving were observed by Toghyani *et al.* (2010) which is not significantly different from percentage gizzard and spleen in broiler reared. Furthermore, in the studied indicated that higher percentage in T3 and T5 accepted in the experiment. In agreement with Malone *et al.* (1993) and Bilgili *et al.* (1990) also found that wood shavings and pin shavings had greater gizzard in broiler chicken reared rather than other bedding materials.

4.1.4 Footpad dermatitis

Footpad dermatitis were showed in Table 4.18 that no effected by different type of bedding materials (P>0.05). At 28 days of age, footpad dermatitis had influence ranged of normal (score 1) from 53.33 % to 31.11 %, ranged related of mild lesion (score 2) from 66.66 % to 46.67 % and ranged related of severe lesions (score 3) from 6.66 % to 0.00 %. Also, bedding materials inclusion that effect a little on score 3 of footpad dermatitis.

At 35 days of age, litter of chicken and moisture content still increased on footpad dermatitis inclusion. Due to 35 days of age observed that bedding materials had high moisture content and had an occurrence on footpad dermatitis increased percentage in score 2 and 3 more than score 1. Moreover, percentage all of treatments in footpad dermatitis were 20.44 % of the broiler chickens had no dermatitis (score 1), 61.77 % of the broiler chickens had mild dermatitis (score 2) and 17.77 % of the broiler chickens had severe dermatitis (score 3), respectively. Through, incidence of footpad inclusion wet bedding materials and effected when grown body weight chicken (P>0.05). However, during those age of broiler chickens observed that no effected of footpad dermatitis at large and deep lesion (score 4).

At 42 days of age, at the end of conduced experiment, broiler chickens grown a higher live body weight and increased the fecal in the pen that created uric acid nitrogen into ammonia was caused of occur the percentage on accidence footpad dermatitis. On average, incidence in footpad dermatitis by different bedding materials were 9.33 % of broiler chickens had no dermatitis (score 1), 46.22 % of the broiler chickens (score 2), 39.55 % of the broiler chickens (score 3) and 6.12 % of the broiler chickens (score 4), respectively (P>0.05). Regarding to results, reversed that bedding materials were small serious disease on the feet of broiler. Footpad could be occur at any stage of the broiler in pen because it may be cause of bedding materials holding was poor litter conditions, in particular, wet or capped litter. Due to score 2 and 3 showed high percentage that incidence on footpad dermatitis. However, it had a low occur in score 4 and score 5 did not a problem at the end with those bedding materials. Bedding materials inclusion did not give any effect to footpad of broiler chicken reared.

Table 4.18. Effect of different type of bedding materials on footpad dermatitis based on percentage at 28, 35 and 42 days of age

Treatments	Foot-pad dermatitis score 28 days (%)				
	1	2	3	4	5
T1	53.33	46.67	0.00	-	-
T2	31.11	66.66	2.22	-	-
T3	46.66	51.11	2.22	-	-
T4	46.66	46.67	6.66	-	-
T5	51.11	48.88	0.00	-	-
SEM	25.93	23.66	3.84	-	-
P-value	0.847	0.794	0.274	-	-
	Foot-pad dermatitis score 35 days (%)				
T1	22.22	64.44	13.33	-	-
T2	15.55	60.00	24.44	-	-
T3	15.55	64.44	20.00	-	-
T4	24.44	60.00	15.55	-	-
T5	24.44	60.00	15.55	-	-
SEM	14.80	13.55	12.29	-	-
P-value	0.486	0.893	0.599	-	-
	Foot-pad dermatitis score 42 days (%)				
T1	11.11	40.00	37.77	11.11	-
T2	4.44	44.44	44.44	6.66	-
T3	8.88	57.78	33.33	-	-
T4	8.88	44.44	42.22	4.44	-
T5	13.33	44.44	40.00	2.22	-
SEM	6.88	5.96	7.80	4.21	-
P-value	0.617	0.170	0.497	0.067	-

Means within the column with the letter not significantly different (P>0.05).
T1= 100% rice husks, T2= 75%:25% rice husks and oil palm frond stems,
T3= 50%:50% rice husks and oil palm frond stems, T4=25%:75% rice husks and oil palm frond stems, T5= 100% oil palm frond stems. 1=normal (no dermatitis), 2=mild lesion (small dermatitis), 3=severe lesion, 4=large and deep lesion and 5=large and deep lesion >50%.

As a results shown that feet lesions of broiler chicken reared on bedding materials were not significantly different (P>0.05) during 28, 35 and 42 days of age. At 28 days of age, broiler chickens had a greater normal score on footpad dermatitis (score 1) when compared with other bedding reared and distribution of footpad score. Same result was obtained by Tercic *et al.* (2015) and Farhadi *et al.* (2016) found footpad had higher with no normal (score 1) during 28 days of age and weight of chicken did not issue key to build up litter. Many factors showed the effect of footpad dermatitis that incidence from issue poor of properties such as faces decomposition, moisture absorption, and ammonia emitted (Bilgili *et al.*, 2009; Davis *et al.*, 2010;

Bjedov *et al.,* 2013; Tercic *et al.,* 2015). Moreover, among commercial broiler reared in the house was the incidence of footpad can vary from 0-100 % in broiler chicken flocks (Ekstrand *et al.,* 1998). Consequently, it also had higher footpad at 35 days of age. The experimental footpad had lower dermatitis 20.44 %, 61.77 % and 17.77 % than Dejong *et al.* (2012) 35.5 %, 26.1 % and 38.4 %, respectively. Lower in the experiment maybe caused by footpad with reared on bedding materials inclusion had better absorption or composition. Moreover, at 42 days of age, footpad of broiler chickens was occurred from score 1 to score 4 but had a lower percentage of footpad. The percentage of footpad was similar result with Davis *et al.* (2010) which was found the bedding types had significant effects on foot pad and hock born score. Bilgili *et al.* (2009) and Tercic *et al.* (2015) found that the incidence of contact dermatitis during increased moisture content and caking score. In contrary, Grimes *et al.* (2006) found no differences in breast blister, hock condition and footpad condition index due to litter materials.

4.1.5 The cost of production different bedding materials

The bedding materials were calculated basis on of commercial market prices in Thailand (Table 4.19). Rice husk bedding was the most expensive in the southern of Thailand for raising chicken and oil palm frond stem was the cheapest of all the beddings used. 1 kg of rice husk was 4.6 Baht while dried oil palm frond stem was only 1.5 Baht per 1 kg of dry. Comparing the cost of bedding materials in broiler reared, the bedding for the T1 was 46.00 THB, for the T2 was 38.25 THB, for the T3 was 32.50 THB, for the T4 was 22.75 THB and for the T5 was 15.00 THB, respectively. Therefore, the lower cost of oil palm frond stems were obtained in respect of availability and economics prices for broiler chickens rearing.

Table 4.19 Cost of production different bedding materials (Baht)

Bedding materials	Price (Baht/kg)	Price (Baht/pen)
100 % Rice husk	4.60.-	46.00-
75 % Rice husk and 25 % oil palm frond stems	3.83.-	38.25.-
50 % Rice husk and 50 % oil palm frond stems	3.25.-	32.50.-
25 % Rice husk and 75 % oil palm frond stems	2.28.-	22.75.-
100 % Oil palm frond stems	1.50.-	15.00-

4.2 Experiment 2: Effects of bedding material and stocking density on performance, carcass characteristic and incidence of footpad dermatitis

4.2.1 Effects of bedding materials and stocking density on physicochemical properties

The comparison of physicochemical properties of bedding with a stocking density of broiler rearing were summarized in Table 4.20 This results showed that no interaction between treatment of bedding material and stocking density and also, was not affected by treatment (P>0.05). However, stocking density had the almost effected on bedding quality (P<0.05). During 1 week of age, water holding capacity from in 10 chicks/m^2 was lower than 15 chicks/m^2. The water holding capacity of bedding material had the higher absorptive capacity and a related rate of moisture content loss (P>0.05). Moreover, During 3 and 6 weeks of age, water holding capacity showed decreased capacity rate and indicated particle size and colour during experiment had varied structure to black when deposition of faces chicken. Because during 3 and 6 weeks of age, moisture absorption measured dry matter increased through the growing as the solid substances while the deposition of faeces solid from chicken and decreased because of the capacity to loss water flow resume from reduced particle size.

Although, the increased stocking density made moisture, pH value, bulk density, and ammonia at 1, 3 and 6 weeks of age to increase as well. The bedding moisture and pH value were the important factors that cause the increase of ammonia emission. Because during 3 to 6 weeks of age broiler grown, increased feeder and increased drinker were rising day by day and also a litter of chicken were increased with a high moisture of these bedding material suppressed ammonia emission (P<0.05).

Table 4.20 The physicochemical properties of bedding material with stocking density 10 and 15 chicks per m^2

Treatments	Moisture content (%)			Water holding capacity (%)			pH level			Bulk density (kg/m^3)			Ammonia (mg/kg)		
	1 wk	3 wks	6 wks	1 wk	3 wks	6 wks	1 wk	3 wsk	6 wks	1 wk	3 wks	6 wks	1 wk	3 wks	6 wks
Bedding materials															
T1	24.23	36.98	45.78^{b}	29.96	24.43	21.28	4.91^{b}	8.06	8.38	157.44	170.59	179.11	0.032	0.114	0.266
T2	22.33	34.81	51.06^{a}	30.73	20.06	18.00	5.51^{a}	8.19	8.61	165.25	178.76	205.21	0.193	0.129	0.241
T3	22.51	38.71	45.75^{b}	29.68	23.98	20.58	5.30^{ab}	8.25	8.54	173.02	186.65	208.16	0.014	0.137	0.267
P-value	0.692	0.084	0.011	0.911	0.246	0.141	0.019	0.462	0.381	0.085	0.128	0.298	0.368	0.541	0.232
Stocking density															
10 per m^2	22.12	33.28^{b}	44.20^{b}	29.31	22.71	20.12	5.40	7.90^{b}	8.22^{b}	153.16^{b}	162.19^{b}	180.60	0.01	0.11	0.20^{b}
15 per m^2	23.93	40.38^{a}	50.86^{a}	30.94	22.94	19.78	5.08	8.45^{a}	8.81^{a}	177.31^{a}	195.15^{a}	208.16	0.03	0.14	0.30^{a}
P-value	0.375	0.000	0.000	0.441	0.917	0.804	0.051	0.000	0.000	0.000	0.000	0.055	0.127	0.070	0.000
Trt*Den	0.416	0.072	0.613	0.686	0.101	0.434	0.553	0.890	0.900	0.897	0.820	0.683	0.336	0.891	0.136
SEM	4.17	2.73	2.89	4.35	4.68	2.78	0.31	0.23	0.28	10.94	12.57	33.85	0.02	0.03	0.02

[a,b] Means within a column with no common superscripts differ significantly ($P<0.05$), Trt*Den: treatment and density,
T1: 100% oil palm from stems, T2: 75:25% oil palm frond stems and rice husks, T3: 50:50% of each bedding material

In this experiment, as previously of studied litter moisture increased from initial value in the experiments as a results of decreased water consumption, caking was confined in litter material to within one of bell drinkers. Moisture content from chicken faeces and dropping water from the drinkers contributed to the high moisture content of the bedding, thus decreasing its absorption capacity. The same results was obtained by Bilgili *et al.* (1990), Garces *et al.* (2013) and Farhadi (2014) with litter material of Rice hulls, sand, pine, wood shaving, coconut husk, corn cob, newspaper and grass to inclusion. Results of water holding capacity was determined by submerging bedding materials in beakers for 30 minutes. Water holding capacity was not significantly affected (P>0.05). Because the bedding particle size was varied to small size, thus it could hold only a small amount of water. This result corresponded with results of Atapattu and Wickramasinghe (2007) indicating that factors that influenced water holding capacity were reduced particle size of bedding material, and increased compaction. In this study, moisture content, pH, bulk density and ammonia were significantly affected by stocking density, but bedding and density were not. The results were in agreement with findings of Farhadi (2014), Garces *et al.* (2013) and Ly *et al.* (2017) who observed the value of bedding increased steadily during in the rearing period by using other bedding types.

They found that the pH and moisture content of organic materials increased by increased stocking density, reared the other bedding material. The different stocking densities had an effect on bedding moisture content, pH, bulk density and ammonia emit in the pens. These results were similar with Dozier *et al.* (2005), who reported that moisture content of bedding increased as stocking density increased. Additionally, they reported high moisture content and pH value were also important factors known to effect ammonia, and may be more ammonia these materials lost to an environment which was not differed significantly experiment rearing (P>0.05).

Davasgaium and Boodoo (1997) agreed that pH level has a cumulative effect on different bedding materials. Garces *et al.* (2013) observed that the organic material water holding capacity had significantly higher or lower absorptive capacity relative to the rate of moisture loss. Fahardi (2014) obtained results showing that bulk density increased in relation to quantity of needed bedding material for poultry rearing, based on depths 5 or 10 cementers. Contrarily, Ataputta and Wickramasinghe (2007) showed that decreased bulk density of bedding material had increased absorbency in rearing, and that moisture absorption and release capacity may be better.

4.2.2 Comparison of bedding material and stocking density on growth performance

The interaction of bedding materials and stocking density had not effect on final body weight (FBW), weight gain (WG), ADG, feed intake, FCR and mortality of chicken reared during 0 to 3, 4 to 6 and 0 to 6 weeks of age (Table 4.21). However, stocking density had significantly affected performance ($P<0.05$). Stocking density showed a greater average of FBW, with (2765.55 g/bird) in low stocking density, while those reared in high stocking density weighted (2571.84 g/bird).

During 0 to 3, 4 to 6 and 0 to 6 weeks of age, WG of low density reared chickens was increased rapidly relate with 964.19 g, 1757.77 g and 2721.96 g compared to high stocking density reared chickens, with 899.04 g, 1628.88 g and 2527.93 g, respectively. Broilers reared in low stocking density pens had better growth performance than those reared in high stocking density. Improved WG each floor planetary in low stocking density was mostly associated to better high stocking density for broiler chicken. At 0 to 3, 4 to 6, and 0 to 6 weeks of age, the target rate of ADG (low stocking density chickens 137.74 g/d, 251.10 g/d and 388.85 g/d to high stocking density chickens of 128.43 g/d, 232.69 g/d and 361.13 g/d, respectively) were met in the experiment. Feed intake increased ($P<0.05$) gradually from 0 to 3, 4 to 6 weeks of age, but after 0 to 6 weeks of age, feed intake declined. This decline was not expected but may be due to the high temperature in the house and due to lack of space to move around. It had limited ability to eat feed which had fallen on the bedding. However, feed intake of broilers reared at the stocking density of 15 chicks/m^2 were lower than that of broilers reared at 10 chicks/m^2 all throughout the experiment.

FCR of broiler chickens increased significantly at 0 to 3 and 4 to 6 weeks of age ($P<0.05$) but at 0 to 6 weeks of age was not affected by stocking density and the interaction of bedding material and stocking density ($P>0.05$). However, FCR of low stocking density chickens was lower than FCR in high stocking density ($P<0.05$) except at 0 to 6 weeks of age. Lower stocking density chickens showed better productivity with different bedding than the high stocking density chickens.

Table 4.21 Comparison effect of bedding materials and stocking density on growth performance in broiler rearing

Treatments	IBW (g)	FBW (g)	WG (g)			Feed intake (g)			ADG (g)			FCR		
			0-3 weeks	4-6 weeks	0-6 weeks	0-3 weeks	4-6 weeks	0-6 weeks	0-3 weeks	4-6 weeks	0-6 weeks	0-3 weeks	4-6 weeks	0-6 weeks
Bedding materials														
T1	43.68	2707.11	941.31	1722.11	2663.43	1373.60	3103.46	4477.06	134.47	246.01	380.49	1.45	1.80	1.68^{b}
T2	44.25	2632.89	926.86	1661.78	2588.64	1381.08	3157.56	4538.64	132.41	237.39	369.80	1.48	1.90	1.75^{a}
T3	43.31	2666.11	926.68	1696.11	2622.79	1382.98	3158.30	4541.30	132.38	242.30	374.68	1.49	1.86	1.73^{a}
P-value	0.292	0.173	0.238	0.288	0.169	0.838	0.590	0.534	0.238	0.288	0.169	0.161	0.098	0.027
Stocking density														
10 per/m^2	43.58	2765.55^{a}	964.18^{a}	1757.77^{a}	2721.96^{a}	1469.90^{a}	3197.03^{a}	4666.93^{a}	137.74^{a}	251.11^{a}	388.85^{a}	1.52^{a}	1.89^{a}	1.71
15 per/m^2	43.91	2571.84^{b}	899.04^{b}	1628.88^{b}	2527.93^{b}	1288.54^{b}	3082.52^{b}	4371.06^{b}	128.43^{b}	232.69^{b}	361.13^{b}	1.42^{b}	1.82^{b}	1.72
P-value	0.501	0.000	0.000	0.001	0.000	0.000	0.037	0.000	0.000	0.001	0.000	0.000	0.046	0.507
Trt*Den	0.232	0.615	0.110	0.903	0.629	0.882	0.723	0.798	0.110	0.903	0.629	0.170	0.809	0.817
SEM	0.98	63.80	16.15	63.11	63.83	28.72	103.83	109.60	2.30	9.01	9.11	0.02	0.07	0.04

[a,b] Means within a column with no common superscripts differ significantly ($P<0.05$), Trt*Den: treatment and density
IBW: initial body weight (g), FBW: final body weight (g), WG: weight gain (g), ADG: average daily gain (g), FCR: feed conversion ratio,
T1: 100% oil palm from stems, T2: 75:25% oil palm frond stems and rice husks, T3: 50:50% of each bedding material

From Table 4.21 showed that increasing stocking density decreased weight gain and growth rate, in agreement with Dozier *et al.* (2005), Feddes *et al.* (2002) and Farhadi *et al.* (2016). The authors reported that the growth rate increased progressing of broiler chickens improved gradually until at 6 weeks of age and then declined when it up to 6 weeks of age. In addition, researchers claimed that body weight and weight gain rate were not affected by different bedding materials, including pine shavings, hardwood bark, refined gypsum and paper Wyatt *et al.,* 1992). Moreover, Mizu *et al.* (1998) and Ramadan and El-Khlaya (2017) concluded that bedding material of rice husks can be used as litter for broiler rearing but without significant effect on growth performance and on the health of chicks. Swain and Sundaram (2000) found that on rice husks and sawdust and coir dust, there were no differences in weight gain rate, feed intake, FCR efficiency production numbers and survivability in stocking density of 15 birds/m^2 compared to those of reared at the same density in this research.

Grimes *et al*. (2006) reported that the growth performance of broiler might be unaffected by quick caking over of the bedding type, which was consistent with the results of the present experiment. Performance in this study was not affected by different bedding materials or stocking density (0.066 m^2/chick). In agreement with this research, most researchers reported the mortality rate was unaffected by stocking densities (Feddes *et al.*, 2002). Moreover, Bilgili *et al.* (2009) and Davis *et al.* (2010) also observed that different between materials had no bearing on the mortality of chickens

4.2.3 Effects of bedding materials and stocking density on carcass characteristics

There was no significantly relation between bedding type and stocking density on carcass parameters (P>0.05). At 6 weeks of age, carcass characteristics of broiler chickens showed that percentage of hot carcass, eviscerates, liver, heart, gizzard, spleen and abdominal fat were not adversely affected by bedding materials and stocking density of 10 and 15 chicks/m^2 (Table 4.22).

Table 4.22 Effects of bedding material and stocking densities on carcass characteristics and internal organs in broiler at 6 weeks of age

Treatments	Hot carcass	Eviscerated	Liver	Heart	Gizzard	Spleen	Abdominal fat
Bedding materials							
T1	92.42	78.20	1.60	0.47	1.10	0.08	0.67
T2	92.06	77.38	1.51	0.50	1.13	0.08	0.49
T3	91.46	76.57	1.54	0.53	1.08	0.09	0.58
P-value	0.867	0.823	0.579	0.129	0.901	0.790	0.532
Stocking density							
10 perm^2	91.84	77.61	1.54	0.50	1.05	0.09	0.60
15 per m^2	92.12	77.15	1.56	0.51	1.16	0.08	0.56
P-value	0.853	0.830	0.758	0.660	0.289	0.529	0.700
Tet*Den	0.841	0.915	0.940	0.412	0.836	0.651	0.854
SEM	3.13	4.49	0.15	0.04	0.19	0.02	0.26

Means within a column with differ are not significantly different (P>0.05), Trt*Den: treatment and density
T1: 100% oil palm from stems, T2: 75:25% oil palm frond stems and rice husks, T3: 50:50% of each bedding material

These results were agreement with findings by Atapattu and Wickramasinghe (2007), Toghyani *et al.* (2009) and Grimes (2004) whose results were also significantly unaffected by the different beddings on carcass, wings, thighs, back, heart, gizzard, and abdominal fat. Bilgili *et al.* (1999) found that chickens reared on pine shavings and sawdust had a larger gizzard than chicken reared on other bedding materials. Chickens reared on wood shavings have been found a bigger gizzard than those reared on others bedding materials (Malone *et al.,* 1983; Huang *et al.,* 2009). They found that broilers reared on wood shavings had larger gizzards than reared on others bedding material. However, the chicks might eat the wood shavings because the researcher explain that low feed intake and WG were observed during the experiment. In contrast, Demirulus (2006) observed that live weight, carcass weight, liver weight, heart weight, and gizzard weight were significantly affected by rearing on pine shavings, straw and mixed bedding.

4.2.4 Footpad dermatitis

The severity scores of footpad dermatitis was summarized in Table 4.23. Overall, the interaction of bedding type and stocking density was not significantly different effect on footpad dermatitis scores for each bedding (P>0.05). However, stocking density showed a significant effect on footpad lesions (P<0.05). At 6 weeks of age, broiler chickens in the lower stocking density pens had a greater normal footpad than those reared in the higher stocking density. Chickens reared in the lower stocking density pens had a higher footpad score (no dermatitis) than chickens reared in the density pens with 40 % and 5.18 % (normal), mild lesions (2 score) 41.11 % and 22.95 %, severe lesions (3 score) 17.77 % and 48.88 %, and large and deep lesion (4 score) 1.11 % and 22.96 %, respectively. This study showed that the stocking density of 15 chicks/m^2 increased the frequency and occurrence of the incidence of footpad dermatitis as compared to those reared at the stocking density of 10 chicks/m^2. In the lower stocking density, bedding material was a key issue reducing foot lesions. Lower frequency and severity of footpad dermatitis in broiler chickens grown in the lower stocking density pens was mostly related with lower bedding material moisture content as compared with the higher stocking density pens. Bedding moisture content and low stocking density had no significant affected on footpad dermatitis, except at the end of the experiment.

Table 4.23 Effects of bedding materials and stocking density on footpad dermatitis of broiler reared at 6 weeks of age

Treatments	Footpad dermatitis score (%)				
	1	2	3	4	5
Bedding materials					
T1	28.88	27.77	28.88	14.89	-
T2	22.77	36.66	33.33	7.22	-
T3	16.11	31.66	37.77	14.44	-
P-value	0.268	0.195	0.389	0.509	-
Stocking density					
10 per m^2	40.00[a]	41.11[a]	17.77[b]	1.11[b]	-
15 per m^2	5.18[b]	22.95[b]	48.88[a]	22.96[a]	-
P-value	0.000	0.000	0.000	0.002	-
Tet*Den	0.299	0.138	0.209	0.257	-
SEM	12.90	7.97	10.77	12.09	-

[a,b] Means within a column with no common superscripts differ significantly (P<0.05), Trt*Den: treatment and density, T1: 100% oil palm from stems, T2: 75:25% oil palm frond stems and rice husks, T3: 50:50% of each bedding material, Scoring on the basis; 1=normal (no dermatitis), 2=mild lesion (small dermatitis), 3=severe lesion, 4=large and deep lesion and 5=large and deep lesion >50%

The results were agreement with Ventura *et al.* (2010) insofar as the occurrence of footpad problems increased among high stocking density chicken. Moreover, Guardia *et al.* (2011) experimented with a stocking density of 17 chicks/m^2, which had a highly significant negative effects on the quality of bedding, which then a negative effect on the chickens.

Farhadi *et al.* (2014) also reported high severity of footpad dermatitis and hock burn in chickens reared at the stocking density of 22 birds/m^2 ($P<0.05$). Footpad dermatitis was a multifactorial problem influenced by a large number stocking density related factors, the most significant being ventilation, feeding, watering, and chicken health (Biedov *et al.*, 2013). In general, it appeared that rearing the broilers at lower stocking density with quality bedding resulted in better footpad fitness, and feathers than higher stocking density. Bilgili *et al.* (2010) reported that damp and coated bedding material was a key cause of greater occurrence of footpad dermatitis, and that ventilation had a significant effect in reducing dampness of bedding.

4.2.5 Cost of production different bedding materials

The costs of bedding materials were determined based on market prices in Thai baht. The lowest cost was obtained from oil palm frond stems (1.5 baht/kg) followed by rice husks (4.6 baht/kg). The costs were 15 baht/m^2 of oil palm frond stem (100 %), 22.75 baht/m^2 oil palm frond stem chopping and rice husks (75 %:25 %) and 33.5 baht/m^2 of each bedding (50 %:50 %), respectively. Due to cost of oil palm frond stem was cheaper than rice husks, but its properties was similar, thus it become a highly valuable bedding material for poultry production. Characterizing of oil palm frond stem may be recommended as safe for used as bedding material and the availability of bedding material under specific circumstances could, however, be a defining factor in deciding which one to use.

CHAPTER V
CONCLUSIONS

Based on experiment 1 and experiment 2, there further seems that different bedding materials did not effect on ABW, WG, FI, ADG, FCR, carcass weight, mortality and footpad dermatitis of broiler chickens significantly ($P>0.05$). Meanwhile, OPFS had a grower on body weight of broiler and the properties of bedding material have been found better than rice husks. The extent of footpad dermatitis parameters were not significantly affected by different type of bedding materials. Nevertheless, broiler chicken in OPFS had a greater normal score (no lesions) compared to other treatment bedding reared and distribution of footpad score at 28 days of age inclusions.

Broiler chickens in the low stocking density of 10 chicks/m^2 had a higher benefit FBW, WG, ADG, FI and FCR compared to those grown in the high stocking density of 15 chicks/m^2. There was no significant difference between relative weights of carcass characteristics. The variation of footpad dermatitis was significantly affected by among of different type bedding materials and stocking density that may be corresponded to increase moisture adsorption and incidence lesion score ($P<0.05$). Of the bedding materials experiment showed the highest severity footpad dermatitis at the highest stocking density of 15 birds/m^2, whereas the lowest stocking density. Inclusion, increasing stocking density of broiler chickens were increased the contact footpad dermatitis than reared at lower stocking density.

SUGGESTIONS

Further research about OPFS in broiler rearing may be utilized as alternative sources of bedding materials to poultry production in a sustainable way because it did not have a problem on broiler chicken’s health. It may be the choice to use as a sources by poultry farm or industry in the studies.

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APPENDICES

Documentation from experiment 1 and experiment 2

Picture 1. Fresh of oil palm stem

Picture 2. Machine shopping

Picture 3. Sample dry under sun air

Picture 4. Sample dry in oven

Picture 5. 100% rice husk

Picture 6. 100% OPFS

Picture 7. 50%:50% rice husk and OPFS

Picture 8. 75%:25% OPFS and rice husk

Picture 9. 75%:25% rice husk and OPFS

Picture 10. Combination bedding

Picture 11. Pen randomly rearing

Picture 12. Starter rearing on bedding

Picture 13. Vaccinated against

Picture 14. Chicken grower phrase

Picture 15. Observed footpad during grower

Picture 16. Chicken live weight

Sample of bedding material collected and analyzed

Picture 17. Sample of bedding collected

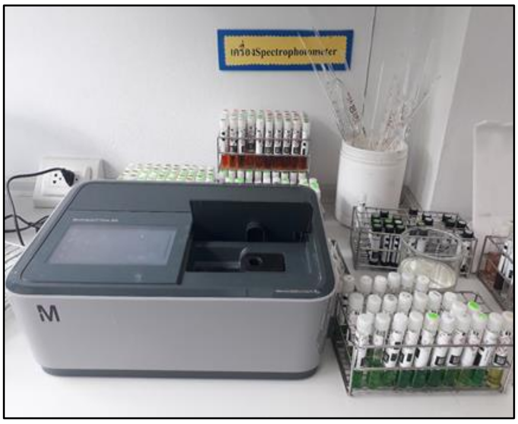
Picture 18. Prepared for DM in Oven

Picture 19. Prepared water solution for ammonia concentration

Picture 20. Pretreated sample into a test tube on NH_3

Picture 21. Prepared sample for pH meter and water holding capacity

Picture 22. Filling sample into nylon socks with deionized water for bulk density



Picture 23. Spectrophotometer for measured NH_3

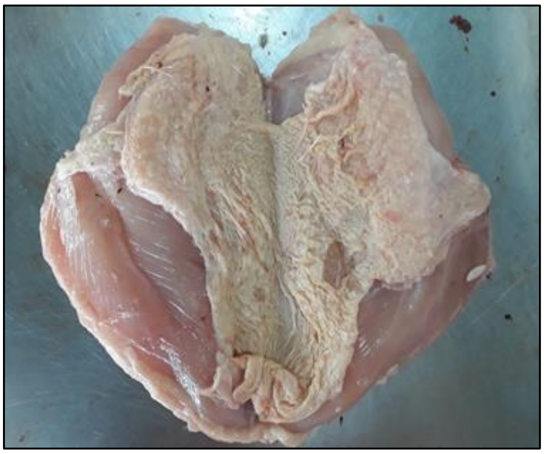
Picture 24. pH meter (Mettler-Toledo)

The slaughter for evalaution of carcass charasteristics on broiler chicken

Picture 25. Hot carcass weight chicken

Picture 26. Cutting part of chicken

Picture 27. Part of head and neck



Picture 28. Part of breast

Picture 29. Part of filet

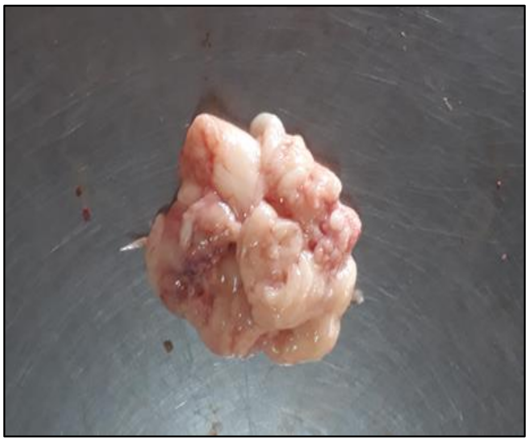
Picture 30. Part of thigh

Picture 31. Part of drumstick

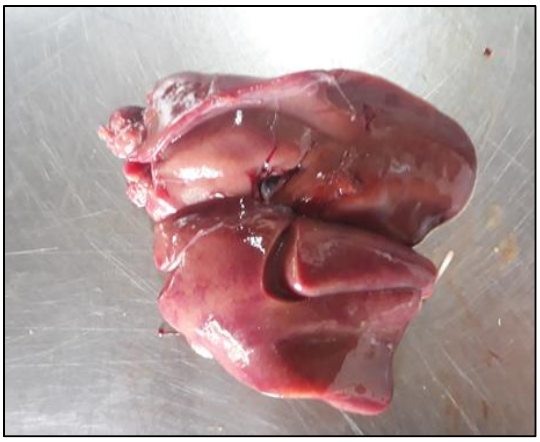
Picture 32. Part of wings

Picture 33. Part of leg

Picture 34. Part of skeletal



Picture 35. Part of abdominal fat



Picture 36. Part of liver

Picture 37. Part of heart

Picture 38. Part of gizzard

Picture 39. Part of spleen

Based on footpad dermatitis score of broiler chicken reared

Picture 40. 1=Normal (no lesion score)

Picture 41. 2=Mild lesion (small dermatitis)

Picture 42. 3=Severe lesion

Picture 43. 4=Large and deep lesion

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List of Publication and Proceeding

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