

ADDIS ABABA UNIVERSITY

COLLEGE OF HEALTH SCIENCES

SCHOOL OF VETERINARY MEDICINE

**EFFECT OF PROCESSED LAYER LITTER AS A REPLACEMENT OF NOUG CAKE
ON FEED INTAKE, MILK YIELD AND COMPOSITION OF LACTATING COWS**

BY

NETSANET AYALEW DESALEGN

JUNE 2010

DEBRE ZEIT, ETHIOPIA

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A thesis submitted to the School of Veterinary Medicine of Addis Ababa University in partial
fulfilment of the requirements for the Degree of Masters in Tropical Animal Production and
Health

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DEDICATION

To my Family

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ABBREVIATION

AM	Morning milk yield
ADF	Acid detergent fiber
ADL	Acid detergent lignin
CP	Crude protein
DMI	Dry matter intake
DT	Dietary treatment
DZARC	Debre Zeit Agricultural Research Center
FAO	Food and Agricultural Organization of the United Nations.
FP	Freezing point
LSD	Least significant difference
masl	Meter above sea level
NDF	Neutral detergent fiber
NPN	Non protein nitrogen
OM	Organic matter
PM	Evening milk yield
SADFI	Straw acid detergent fiber intake
SADLI	Straw acid detergent lignin intake
SashI	Straw ash intake
SAS	statistical analysis system
SCPI	Straw crude protein intake
SE	Standard error
SEQ	Sequence
SDMI	Straw dry matter intake
SNF	Solid not fat
SOMI	Straw organic matter intake
SPSS	Statistical package for social science
TADFI	Total acid detergent fiber intake
TADLI	Total acid detergent lignin intake
TASHI	Total ash intake

TCPI	Total crude protein intake
TDMI	Total dry matter intake
TFATYLD	Total fat yield
TMLKYLD	Total milk yield
TMPROYLD	Total milk protein yield
TNDFI	TotalNutral detergent fiber intake
TOMI	Total organic matter intake
TSNFYLD	Total solid not fat yield

ABSTRACT

A study was conducted between September 2009 and March 2010 to assess the level of poultry litter use in Deberzeit town and to evaluate the replacement effect of layer litter in feed intake, milk yield and composition lactating dairy cows. Seventy five milk producers were interviewed by using semi-structured questionnaire. They were selected randomly from membership list of Adda'a Liben Dairy and Dairy products marketing Association.

Eight lactating animals at mid lactation stage were assigned to four treatments containing poultry litter 0 % (control), 5%, 10% & 15% in across over design. Significant proportions (60%) of dairy producers were found to use poultry litter as an ingredient for dairy cattle feed with mean inclusion rate of 21% in a concentrate mixture. The price of poultry litter whether it is processed (162 birr per quintal) or unprocessed (84 birr per quintal) was lower than the price of Noug cake (240 birr per quintal) during the study period.

Bad flavor and bad taste of milk were the main reasons for those who stopped using poultry litter as feed ingredient. Higher proportion of respondents did not have any complain regarding the health of dairy animals due to feeding poultry litter. No significant difference ($p>0.05$) was observed in total dry matter intake among the four treatments. There were no significant difference observed in milk yield & composition among the four dietary treatments. However, there were significant differences among treatments when observed across periods in feed intake, milk yield and composition. It can, therefore, concluded that poultry litter can be good replacement for resource poor producers.

Key words: cross-over, milk composition, milk yield, poultry litter

1. INTRODUCTION

Ethiopia holds large potential for dairy development and has the largest livestock population in Africa. FAO estimates that about 51 percent of the human population in Ethiopia is undernourished and over two million people are considered to be chronically food insecure (FAO, 2001). Compared to other countries in Africa, Ethiopians consume less dairy products and per capita consumption of milk in Ethiopia is as low as 17 kg while the average figure for Africa is 26 kg per head (Gebre wold *et al.*, 1998). The dairy sector, especially at the smallholder level, can improve the nutritional status of consumers (Mohamed *et al.*, 2010). The existing high demand for dairy products in the country is expected to induce rapid growth in the dairy sector. Factors contributing to this high demand include the rapid population growth (estimated at 3 percent annually), increased urbanization and expected growth in incomes (Delgado, 1999).

Over the last decade following the political changes in 1993, the dairy sector in Ethiopia has shown considerable progress (Mohamed *et al.*, 2010). Total milk production grew at an estimated rate of 3 percent as compared to 1.8 percent during the period of 1975-1992, thus ending the long-time trend of declining per capita milk production in the country. The progress achieved is mainly due to technological intervention, policy reforms and population growth. The dairy sector in Ethiopia is expected to continue growing over the next one to two decades given the large potential for dairy development in the country, the expected growth in income, increased urbanization, and improved policy environment. The shift towards market economy is creating large opportunity for private investment in urban and peri-urban dairying. However, the main source of growth is expected to be the growth in demand for dairy products. (Mohamed *et al.*, 2010).

In traditional cattle-keeping the animals rely almost entirely on what is locally grown on the farm; mostly pasture grass and some crop residues. The production capacity of the local animal is generally very low. Due to the scarcity as well as poor quality of feeds available, the productivity of crossbreeds is also low. In order to exploit the production capacity, the crossbreeds require not only more feed, but also feeds of better quality. If these facts are not taken into consideration properly the high-grade animals will suffer and they will also produce below their production capacity. The experience from Ethiopia and elsewhere has also proved that the crossbred animals

often have been underfed and consequently also underutilized. Poor feeding and breeding managements are the most important bottleneck for economic exploitation of dairy cattle in Ethiopia. (Mohamed *et al*, 2010).

Dry matter intake and digestibility will be lowered under protein deficient diets. However, it is possible to minimize these losses through protein or non-protein-nitrogen (NPN) supplementation. Commercial protein sources that could supplement the low quality feeds are not only expensive but also are inaccessible to resource-poor farmers (Nwogu *et al.*, 2003). Use of urea and urea molasses blocks have also been introduced as an alternative means of improving the nitrogen supply to the rumen microbes. However, these sources are equally expensive to most farmers. Moreover, they can impose danger of toxicity to the animals Therefore; we should look at another protein source to supplement the protein deficient feeds. In this regard poultry litter can be an option for most dairy producers as non-conventional feeds due to its feature that can replace most valuable protein feeds such as soybean meal, groundnut meal, cottonseed cakes (Onimisi and Oimage, 2006)

Generally, the disposal of poultry litter from intensive poultry production plants may require extra expenses in addition to its impact on environmental pollution. Moreover, feedstuffs for animals are getting progressively expensive, thus necessitating minimization of feed cost, which could be achieved through the incorporation of relatively cheap and non-conventional feed ingredients. Although, the chemical composition of poultry litter is variable, it is rich in crude protein (CP), which could be as high as 31% (Banerjee, 1996). Thus, utilization of poultry litter as animal feed ingredient, apart from reducing environmental pollution is assumed to have the advantages of providing a low cost feed ingredient.

Numerous research results have proven that poultry litter has the potential to replace many expensive grain meal-based supplements as a substitute for legumes during the dry season, thus decreasing feed costs and sustain higher ruminant livestock productivity. It has been shown that poultry manure/litter is more valuable as a feed ingredient than as a fertilizer. In fact, the economic value of poultry manure/litter as a feed ingredient in balanced diets for several classes of ruminants is up to four times greater than its value as a fertilizer. In addition to offering an

economic advantage, using poultry manure/litter as animal feed is environmentally friendly (Anakalo *et al.*, 2009).

There are lots of small and large scale intensive types of poultry production in Debre Zeit area. The area is also known for its potential in dairy production. There are farmers who currently feed poultry litter to their cattle as a supplement. Though poultry litter is being used as a feed supplement in the area no well documented information is available regarding the levels of poultry litter supplementation and their impact on productivity of dairy cattle.

Therefore, this study was designed with the objectives:

- To investigate the effect of different levels of layer litter inclusion in the commonly used feed supplements of cross breed (97.3% exotic blood) cows, on feed intake, milk yield and milk composition.
- To assess the current level of awareness and use of poultry litter as a supplement diet by smallholder dairy farmers in Debre Zeit area.

2. LITERATURE REVIEW

2.1. Overview of animal waste as livestock feed

A more efficient strategy than use of animal waste as fertilizer can be process it directly in to animal feed (yeck, 1975). The animal manure nutrient contents have been shown to be 3-10 times more valuable as animal feed than as plant nutrients (Muller, 1980). The chemical composition and thus the nutritive value of wastes depend on species and classes of animals, production capacity, nutrient intake, digestion and absorption, feeding management, plane of nutrition and composition of diets, waste management and disposal system, beeding and other added materials and environmental factors. The feeding value of recycled manure has been considered higher for a ruminant due to their ability to utilize non-protein nitrogen (NPN) (Zinn *et al.*, 1996). This gives them an advantage over other livestock. In such a recycling situation, circularly integrated farms will theoretically be able to offer about 15–20% more animal products without additional land and feed requirements. Poultry manure may be an effective and economical protein and mineral supplement in smallholder farms.

2.2. What is poultry litter?

Poultry litter is animal waste that can be used as animal feed, fertilizer and fuel. Poultry litter contains a mixture of chicken manure, feathers, spilled food, and bedding material. The litter produced in a given operation depends upon management techniques includes kind and amount of feed, type and amount of litter, type of bedding material (Alan and Yoganand, 2005). Bedding may consist of wood shavings, sawdust, straw or other fibrous materials. The litter usually contains 20 to 25% moisture (Fontenot and Hancock, 2001).Poultry manure in particular, can replace most valuable protein feeds such as soybean meal, groundnut meal, cottonseed cakes (FAO, 1982).

2.3. Poultry litter in livestock production

The feeding values of poultry manure to ruminants, its nitrogen as a source of dietary crude protein is considered as a better source of non-protein nitrogen (NPN) than urea (Ahmed. *et al.*, 2007). Numerous research results have proven that, poultry litter has the potential to replace many expensive grain meal-based supplements as a substitute for legumes during the dry season, thus decreasing feed costs and sustain higher ruminant livestock productivity (Kunju 1986; Aarts *et al.*, 1990, Hadjipanayiotou *et al.*, 1993; Chen *et al.*, 1993, Lanyasunya *et al.*, 2006). Intensive chicken farming leads to solids disposal problems worldwide. While animal Waste is commonly applied to farmland as a fertilizer, it is known to be more valuable as a feed nutrient to livestock. Due to the high fiber and non-protein nitrogen content of the wastes and ruminants are best suited for utilization of the wastes. In fact, the economic value of poultry manure/litter as a feed ingredient in balanced diets for several classes of ruminants is up to four times greater than its value as a fertilizer (Evans *et al.*, 1986). In addition to offering an economic advantage, using poultry manure/litter as animal feed is environmentally friendly.

Many experimental results have revealed that dried or ensiled poultry litter can be successfully included in ruminant livestock diets as a protein supplement (Fontenot, 1990). For instance, goats fed poultry excreta produced significantly more milk (600 vs 558 g/d) compared to those on a concentrates diet (Hadjipanayiotou *et al.*, 1993). Mean daily milk production of cows fed poultry waste nearly equaled that of cows fed control rations (Silva *et al.*, 1976). A study in the Sudan showed that the dry matter intake, digestibility and degradability of sheep & goats supplemented with poultry litter was higher and small ruminant were found to be well adapted to inclusion of poultry litter in diets up to 36% with out causing any health problems or remarkable decrease in daily feed intake (Nuha and Faisal, 2008). Feeding broiler litter did not adversely affect carcass quality and taste of the meat in beef cattle (Fontenot and Hancock, 2001).

2.4. Nutritional value of poultry litter

Most poultry litter/manure contain about 25 to 50% crude protein on a DM basis (Fontenot and Hancock, 2001), about half of which drives from uric acid, which can be efficiently used by rumen microbes for protein synthesis. In addition, poultry manure contributes significant amounts of Ca, P, K and numerous trace minerals (Ruffin and McCaskey, 1990). It is also a good

source of Non protein nitrogen (NPN) for ruminants (Ensminger and Olentine, 1978; Perry, 1980, Hadjipanayiotou, 1984) provided it is processed well in order to destroy potentially harmful microorganisms (Rogers and Poore, 1994). Therefore, the nutritional value is similar to or higher than good quality legume hay (Fontenot and Hancock, 2001).

According to Lanyasuna *et al.*, (2006), there is variation in the nutrient content of poultry litter from farm to farm depending on the quality of the ration offered to the birds, their age, amount of feed wasted, the amount of water spillage and more importantly, the type and amount of bedding material used. Depending on the management and feeding regime poultry manure contains phosphorous (P: 0.56 - 3.92%), potassium (K: 0.73 - 5.17%) and calcium (Ca: 0.81 - 6.13%). The litter also contains magnesium (Mg), sulphur (S), manganese (Mn), copper (Cu), zinc (Zn), chlorine (Cl), boron (B), iron (Fe), and molybdenum (Mo) in significant proportion. These nutrients basically originate from the feed, supplements, medications, and water consumed by the birds (Paul *et al.*, 1993). Good-quality broiler litter is approximately equal to good-quality alfalfa hay, based on nutrient analysis made by Bagley and Richard, (1998). Uric acid is the major N component of poultry excreta. It can be degraded more slowly than urea, creating a favorable ammonia pattern for efficient utilization in ruminant (Oltjen *et al.*, 1968; McDonald *et al.*, 1988) by rumen microbes for protein production. The rumen of ruminant animals can break down and convert broiler litter in to nutrients which can be absorbed and used by the animal (Bagley and Richard, 1998).

2.5. Poultry litter and animal health

Two serious problems associated with the feeding of poultry excreta to livestock are pathogenic organisms and medicinal drugs. According to Simonsen *et al.*, (1987), poultry accounted for 50.1% of all non-human *Salmonella* isolates. Clegg *et al.*, (1995) and Hogg *et al.*, (1990) also confirmed the isolation of many microorganisms from the faeces of hens. *E. coli* infection, which is responsible for major losses in the poultry industry, is commonly found in poultry litter and faecal material (Fontenot, 2000). Poultry waste can be rendered free of pathogens by processing (Fontenot, 2000) such as autoclaving, fumigation and dry heat alone or in combination with formaldehyde. Furthermore, other methods of processing such as ensiling and deep stacking have been proposed (Hadjipanayiotou, *et al.*, 1993). Pathogenic bacteria in poultry litter can be killed

with mild heat treatment (60°C) which can be generated naturally if manure piles are properly covered to minimize N loss and oxygen entry. Ensiling helps in destroying harmful microorganisms possibly present in the manure and maintains its nutritive value. Most antibiotic fed to chicken in intensive systems are not a problem when the manure is fed to cattle. Many of the antibiotics are degraded by micro-organisms present in the manure during processing. Essentially all the antibiotics approved for chicken are also approved for cattle (Lanyasunya *et al.*, 2006). Generally poultry litter is as safe as any other feed stuff if processed and handled properly (Bagley and Richard, 1998).

2.6. Processing of poultry litter

It is important to note that, when poorly handled, poultry manure can be a source of hazardous contaminants (hard objects, debris, harmful organisms) thereby posing serious danger not only to ruminant livestock but also to humans who depend on these animals for products such as milk. Processing is necessary for destruction of pathogens, improvement of storage and handling characteristics, and maintenance or enhancement of palatability (Cast, 1978). Processes that have been used include dehydration, pelleting, ensiling alone or with other ingredients, deep stacking and composting.

2.6.1. Types of processing

Dehydration

Heat drying has been used to process poultry wastes (Fontenot and Ross, 1980). The resultant product is rather dusty but has good keeping qualities. Heat drying may result in loss of nitrogen, at least with poultry wastes, but acidifying the waste before drying was shown to decrease the nitrogen loss (Harmon *et al.*, 1974).

Ensiling

Ensiling animal wastes alone or in combination with other ingredients has been successful. Good silage was made by mixing corn forage and broilers litter (Harmon *et al.*, 1975a). For good ensiling the level of waste should probably not exceed 30% of the dry matter. Feeding this kind of silage has resulted in efficient nitrogen utilization in sheep (Harmon *et al.*, 1975b) and performance in finishing cattle was similar to that of cattle fed corn silage plus conventional protein supplement (McClure and Fontenot, 1985). Poultry litter can be ensiled alone, but the moisture level should be about 40% for good ensiling (Caswell *et al.*, 1978). Satisfactory ensiling was achieved with mixtures of broiler litter and rumen contents (Chaudhry, 1990). The final pH value was 5.6. Caged layer waste has been successfully ensiled with hay (Saylor and Long, 1974), sugarcane bagasse (Samuels *et al.*, 1980), corn stover (Moriba *et al.*, 1982), corn forage (Goering and Smith, 1977), and sorghum forage (Richter and Kalmbacher, 1980).

Deep Stacking

Poultry litter is stacked at a depth of a minimum of 1.5 meters, in a building with ample ventilation. Maximum temperature is reached after a few days, after which the temperature in the stack gradually decreases until it reaches ambient temperature. In an early experiment, maximum temperature of 50°C was reached 4 to 8 days after deep-stacking broiler litter to a depth of 1.2 meters (Hovatter *et al.*, 1979). The maximum temperature appears to be related to moisture level. The highest temperature recorded for litter deep stacked at 15% moisture was 57.5°C, compared to 61.2°C and 60.2°C for litter deep stacked at 25 and 35% moisture, respectively (Chaudhry, 1990). Increasing the moisture above 35% appeared to result in lower maximum temperatures (Abdelmawla, 1990). Highest temperatures at 46 centimeters from the top of 1.2 meter stacks were 65.9°C, 63.9°C, and 62.8°C, for litter stacked at 35%, 40%, and 45% moisture, respectively. Nitrogen utilization was similar for ruminants fed poultry litter ensiled or deep-stacked (Abdelmawla *et al.*, 1988). Performance was similar for finishing cattle fed ensiled broiler litter-corn forage or ensiled corn forage and deep stacked broiler litter (McClure and Fontenot, 1985). Excessive heating may occur during deep stacking, resulting in a dark, charred-appearing litter, which may reduce dry matter digestibility (Ruffin and McCaskey, 1990). Evidence was obtained that the nitrogen in "charred" litter from a stack exposed to the weather was less soluble and

lower in rumen degradability than normal deep-stacked litter (Kwak, 1990). Covering the stack with polyethylene resulted in lower temperature in the stack (Rankins *et al.*, 1993).

Composting

This process involves initial stacking of the wastes and mixing to enhance aerobic fermentation. Composting is described as the "rapid but partial decomposition of most solid organic matter by the use of aerobic microorganisms under controlled conditions" (Anonymous, 1970). This process has been used to process animal wastes for land application, but animal wastes may be composted for use as animal feed (Cast, 1978). Considerable loss of nitrogen may occur during composting. Composting litter by stacking, mixing after 2 days, then at weekly intervals for 6 weeks resulted in a 15% decrease in crude protein (Abdelmawla *et al.*, 1988). The same authors reported that apparent digestibility of dry matter and crude protein, and nitrogen utilization by sheep fed composted litter were similar to those for sheep fed deep-stacked litter.

2.7. Poultry litter inclusion

Inclusion of poultry litter in the ruminant diet beyond 30% will result in decreased feed intake and digestibility (Lanyasunya *et al.*, 2006). Cows fed poultry waste at 20 or 30%, of the ration DM had lower milk yield and concluded that dried poultry waste could make up 10% (as fed) or rations for lactating cows (Silva *et al.*, 1976). On the other hand Broiler litter is not palatable as other common feed sources, and cattle require an adaptation time to get accustomed to it (Bagley and Richard, 1998).

3. MATERIALS AND METHODS

3.1. The study site

The study was conducted in Deberzite area on market oriented smallholder dairy farmers and at the Debre Zeit Agricultural Research Center. Debre Zeit is located at 45 km south east from Addis Ababa. The area has an altitude of about 1900m above sea level. The maximum and minimum temperatures and the mean annual rainfall of the area are 24.3⁰C, 8.9⁰C and 851mm respectively. The climate of the area is mostly tepid to cool moist mid to high altitude (DZARC, 2005). The research center is located at 8⁰ 44'N and 38⁰ 85' E

3.2. Study method

The study was conducted by way of questionnaire survey and feeding trial.

3.2.1. Questionnaire survey

A semi- structured questionnaire survey was conducted by way of personal interview. The questionnaire that was prepared in English was translated to Amharic for easy administration. The questionnaire was closed type for its major part and was administered after pretesting and readjusting it.

Sample size was determined based on the formula recommended by Arsham (2007) for survey studie

$$N=0.25/SE^2$$

With the assumption of 6% standard error a total sample size of 75 smallholders were considered for the study. The smallholders were randomly selected from the membership list of Ada'a Liben Dairy and Dairy Products Marketing Association. The questionnaire was focusing on the practice of using poultry litter as livestock feed especially to dairy animals, level of inclusion in the concentrate mixture especially for dairy cattle and perceptions of producers' with regard to the effects of poultry litter on yield and composition.

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3.2.2. Feeding trial

Experimental Animals

In the four months of feeding trial eight cross breed cows (Holstein and local breed cross), of 97.3% blood level and in mid lactation were used. All the cows were on their 90th day of milk production at the commencement of the trial. The cows were vaccinated against Foot and Mouth disease (FMD), Lumpy skin (LSD), Blackleg, Anthrax and Bovine Pasteurellosis. California Mastitis Test (CMT) tests were conducted in all the experimental animals prior to the feeding trial and all the cows were found free of mastitis.

The cows were fed and watered individually. Every morning the animals were visually inspected for signs of ill health. Milking was conducted manually and twice per day. Udder and hand washing, using clean utensils for milk handling during milking were part of hygienic measures implemented during the experimental period.

Experimental Diets

The feedstuffs used in the experiment were teff straw and fresh alfalfa as roughage feed; and concentrate feed composed of poultry litter, noug-cake (*Guizotia abyssinica*), wheat bran and wheat middling. Fresh alfalfa was incorporated to supplement the cows with vitamin A, since poultry litter contains very low or no vitamin A. Table-1 illustrate the ratio of incorporating the different components in the concentrate mixture. The daily ration of each cow was constituted of 10 kg teff straw, 4 kg of fresh alfalfa and 5 kg concentrate. The concentrate was offered in two portions at 8:00 AM in the morning and 3:00PM in the afternoon. Teff straw was fed day and night. Clean water was made available at all the times. Feed offered and refused were measured by using suspended weighing balance and recorded on daily basis. Before the start of the feeding trial the cows had two weeks of adaptation period to diets and facilities.

Table 1. Concentrate feed ingredients and their rates of incorporation in the four dietary treatments.

Ingredient (%)	D.Treat. 1 (control)	D.Treat.2	D.Treat.3	D.Treat.4
Noug seed cake	18	13	8	3
Layer litter	0	5	10	15
Wheat bran	60	60	60	60
Wheat middling	21	21	21	21
Salt	1	1	1	1
Total	100	100	100	100

D.Treat. dietary treatment

Experimental design

The eight crossbred cows were randomly assigned to four groups (two cows per group). A change-over design (cross over design) was used for the feeding experiment with four dietary treatments assigned to each group of animals, but one dietary treatment per period (table 2). One treatment period had one month duration. The cross over design was used to reduce error (variation) that may arises due to variation in experimental units under identical treatments and due to shortage of experimental animals. The sequences in which the dietary treatments applied to an experimental unit (subject) could have some influence on the effects of the different dietary treatments. Thus, different dietary treatment sequences were used to eliminate sequence effects. In the cross over design, each subject receiving a sequence of experimental dietary treatments was used to compare effects of individual treatments, not the sequences. The carry over effect (residual effect) is the effect of the first treatment on the second and on the subsequent treatment periods can be estimated. (Jones and Donev, 1996; Jones and Kenward, 1989) .Treatments were arranged in the following sequences(S):

Table 2: Sequence of offering the experimental diets to the four groups of experimental animals

Animal Group(sequence)	Cow ID	Feeding period (months)			
		1 st	2 nd	3 rd	4 th
1	002&003	D.T. 1 (0% poultry litter)	D.T. 4 (15% poultry litter)	D.T. 3 (10% poultry litter)	D.T. 2 (10% poultry litter)
2	006& 008	D.T. 3 (10% poultry litter)	D.T. 2 (5% poultry litter)	D.T. 1 (0% poultry litter)	D.T. 4 (15% poultry litter)
3	004& 005	D.T. 2 (5% poultry litter)	D.T. 1 (0% poultry litter)	D.T. 4 (15% poultry litter)	D.T. 3 (10% poultry litter)
4	001& 007	D.T. 4 (15% poultry litter)	D.T. 3 (10% poultry litter)	D.T. 2 (5% poultry litter)	D.T. 1 (0% poultry litter)

D.T. Dietary treatment

Data recording

The amount of feed offered and refusals were measured and recorded daily. Daily feed intake was calculated by subtracting the total feed leftover from the total feed offered. Daily samples of feeds offered and refused in each treatment were taken, bulked and sub-samples were taken after thorough mixing for laboratory analysis. More over, Composited milk samples were collected at the beginning and final week of each dietary treatment period for milk composition analysis using LactiCheck®

Daily milk yields of experimental animals were measured in liters by using graduated measuring cylinder and were recorded.

Chemical analysis of feed samples

The chemical analyses were done at the Nutrition Laboratory of Debre zeit agricultural research center. Feed offers from all treatments and refusal from tef straw samples were taken daily per cow, bulked on a weekly basis and oven dried at 65 °C for 72hrs and grounded to pass 1mm sieve of a Wiley mill. The dried and ground samples were subjected to proximate analysis per AOAC (1980) procedure. Dry matter and Ash content of composite samples of feeds were determined by oven drying at 50 °C for 72hrs and combusting in a muffle furnace at 500 °C overnight, respectively. Nitrogen content of feed were determined by Micro-Kjeldahal method and calculated as N*6.25. Neutral detergent fiber (NDF), Acid detergent fiber (ADF) and Acid detergent lignin (ADL) contents of feeds samples were determined according to Van Soest *et al.*, (1991).

Milk yield and composition analysis

Milk yield of each cow was recorded twice per day for the whole duration of that experimental period. At the beginning and end of each dietary treatment individual cow milk samples were placed in a clean plastic cup, immediately after milking, placed in icebox and transported to the Hawassa University, College of Agriculture Dairy Lab for composition analysis within half a day after milking. The milk samples were analyzed for fat, SNF, protein and lactose contents, as well as for density and freezing point. LactiCheck® (page & Pedersen, international.Ltd USA, 2004) instrument was used for the above indicated composition analysis. LactiCheck® measures Fat 0.5 - 9% ($\pm 0.08\%$), Solids Not Fat (SNF) 6 -12% ($\pm 0.2\%$), Density 1.0260-1.0330 g/cm³ (± 0.0005 g/cm³), Protein 2 - 5% ($\pm 0.2\%$) and FP (°C) Measuring Cycle ~ 85 seconds.

3.3. Statistical analysis

The collected data were coded as deemed necessary and entered into the Microsoft excel program and summarized by calculating means, standard errors and proportions and frequencies using SPSS (version 13.0, 2004). While feeding trial analysis was carried out using the mixed procedure of SAS (version 8) (2007). Treatment means were computed using the LSMEANS option and separated using comparisons of least squares mean using t-tests. The person correlation test was applied to see the relationship between parameters.

The following model was used to analyze the effect of supplementation of poultry litter on feed intake, milk yield and milk composition:

$$Y_{ijk} = \mu + S_i + C_{ij} + P_k + T_t + E_{ijk},$$

Where,

Y_{ijk} = response during the k th period of the j th cow in the i th sequence group

$i = 1, 2, 3, 4;$

$j = 1$ to $8;$

$k = 1, 2, 3, 4$

μ = population mean

S_i = sequence effect (Seq.)

C_{ij} = the effect of the j th cow on the i th sequence

P_k = period effect,

T_t = treatment effect ($t = 1, 2, 3, 4$) and

E = residual error.

4. RESULTS

4.1. Survey

4.1.1. Demographic characteristics of household heads

Table3 shows some of the demographic characteristics of respondents. The majority of the respondents (57%) were females. Sixty five percent of the respondents were age 40 years and above. 21% of the respondents were illiterate. The proportion of respondents that had post secondary school education was 37.3%. For the higher proportion of the households the major source of income was livestock related activity, especially dairy production (Table 3). Twenty eight percent of the respondents were working in government and non-government organizations and uses dairying as additional source of incomes.

Table 3. Demographic characteristics of interviewed smallholders

Sex	N	Percent
Male	32	42.7
Female	43	57.3
Age		
≤ 30	14	18.7
31- 41	12	16
41-50	20	26.7
≥ 51	29	38.7
Educational status		
Degree	4	5.3
Diploma	11	14.7
Certificate	13	17.3
Secondary school	15	20
Primary school	16	21.3
Illiterate	16	21.3
Source of income		
Salary	5	6.7
Livestock production	49	65.3
Trade	3	4
Pension	4	5.3
Salary and livestock production	14	18.7
Job		
Pension	15	20
Non-governmental employee	5	6.7
Own	24	32
Daily laborer	1	1.3
House wife	22	29.3
Governmental employee	8	10.7

4.1.2. Cattle herd size

The average cattle herd size and average number of milking cows were 5.29 and 2.53, respectively (Table 4). With the present average number of milking cows in a given household could get a minimum of 10 liters of milk per day which can be sold out and consumed at the household level. This is because the majority of the cows were cross bred.

Table 4. Cattle herd size in the surveyed smallholder farms

	N	Min	Max	Mean	S.E
Cattle herd size	75	1	50	5.29	0.714
Number of milking cows	75	0	25	2.53	0.346

4.1.3. Concentrate mixture and poultry litter inclusion rates

The different feed ingredients used in the concentrate mixture as cited by the respondents are shown in table 5. About 60% of the respondents were using poultry litter in the concentrate mixture for their dairy animals with an average inclusion rate of 21%. The mean inclusion rate of wheat bran, wheat middling and Noug-cake were 50%, 15% and 16%, respectively. Wheat bran, Noug-cake and poultry litter were the most frequently cited concentrate feed ingredients in the study area.

Table 5. Concentrate components and their inclusion rates in smallholder dairy farms, Debre Zeit area.

	Number of smallholders		Mean Inclusion
	N	%farmers of using ingredient	%
Wheat bran	47	62.7	49.98
Wheat middlings	13	17.3	15.46
Noug cake	40	53.3	16.04
Poultry litter	45	60	21.69
Salt	35	46.7	0.8871

Lack of knowledge, personal preference, refusal by animals to eat and relatively high cost of poultry litter were among the reasons mentioned for not using poultry litter in dairy cows concentrate mixtures.

4.1.4. Type and price of poultry litter

There were two types of poultry litter, processed and unprocessed ones. The former is cleared from any foreign material like dust, wood shavings, feathers, nails and other harmful materials. However, the large majority (88% of the poultry litter users) purchasing unprocessed poultry litter and were processing it by sieving to discard extraneous materials. The average price of the unprocessed and processed poultry litters were birr 85.00 and 163.00 per quintal, respectively (table 6). The price of noug cake that the poultry litter is replacing in the concentrate mixture was birr 240.00 per quintal at the time of the study.

Table 6. Type proportions of producers who used and price of poultry litter

Type of poultry litter	Proportions of producers		Price (birr/quintal)		
	N	%	N	Mean	SE
Processed	8	11.6	8	162.8	9.04
Unprocessed	61	88.4	58	84.9	1.33

SE= Standard error

4.1.5. Effects of poultry litter feeding to dairy cows

Table 7 illustrates the perceptions of the respondents with respect to the effects of using poultry litter. Increased milk yield, improved milk quality and reduced feed cost were the most frequently cited positive effects mentioned by respondents. However, some 8.6% of the respondents said that they did not see any benefit from using poultry litter.

Table 7. Smallholders' perceptions of the effects of feeding poultry litter to dairy cows

Effects	N	%
Increase in milk yield	50	41.3
Decrease in feed cost	36	29.8
Milk quality improvement	29	24
No benefit	6	5
Total	121	100.1

Milk yield increases mentioned were ranging from 0.3 to 1.2 liters per day per milking cow. Good flavor, taste and appearance were mentioned as quality attributes of feeding poultry litter. However, 34% of the respondents were not able to indicate the improved aspect of milk quality, although they mentioned quality improvement as benefit of feeding poultry litter.

Respondents who complained the negative side of poultry litter were being asked to explain the quality defects they faced. This problem was also measured in relation to rejection of milk from cooperative. Equal proportions (40%) of respondents have had either bad flavor or bad taste problems in their milk (fig1). The milk was rejected from the cooperative. On the other hand, 20% of those who had faced the rejection problem faced other types of quality defects which they couldn't explain. Half of those who had quality defect problem due to poultry litter stopped using poultry litter. However, the other half continued to feed to their animals after they change mode of using that is by decreasing the inclusion rate. Generally the proportion of respondents who had faced quality defect problem was insignificant.

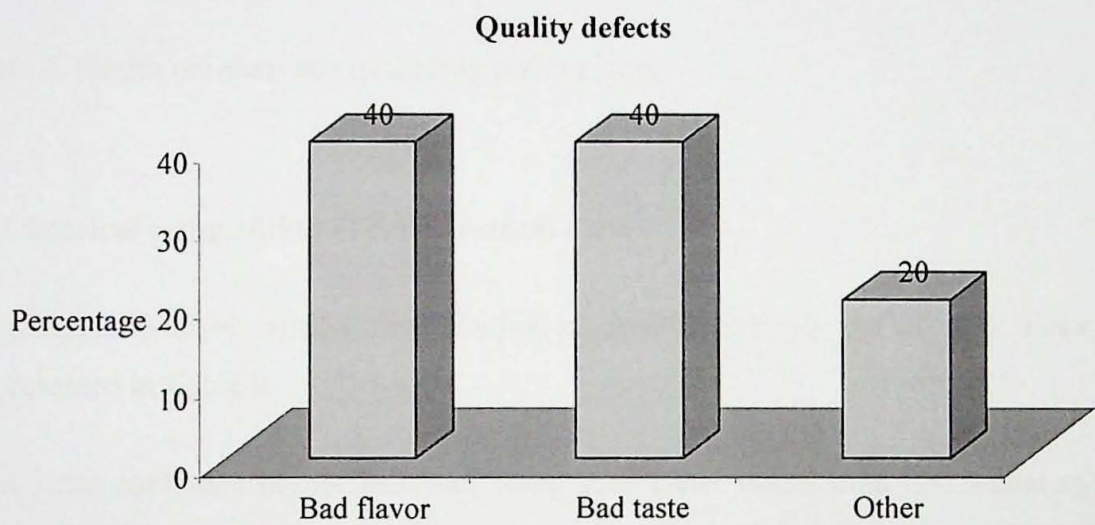


Figure 1. Type of presumed quality defects due to poultry litter feeding

Nearly 20% of the producers reported health problem in their animals due to feeding poultry litter (fig 2). However, 8% of the producers did not have any kind of health problem in their animals. Only 4.3% of the respondents got extension service on poultry litter usage as a feed ingredient and its mode of preparation or processing. They got the extension service either from government organizations such as woreda agricultural bureau or research centers or from non governmental organizations.



Figure 2. Health problem due to feeding poultry litter

4.2. Chemical composition of experimental diets

The chemical analysis results of the individual feed ingredients and the four dietary treatments are presented in Table 8.

Layer litter contained higher ash than Noug seed cake, wheat bran and wheat meddling. The results indicate that the energy value of poultry litter was lower than that of Noug seed cake as well as wheat bran and wheat middlings. Lowest levels of CP and DM and highest levels of NDF and ADF were determined in teff straw compared to the other feed samples. ADL level of teff straw used in the study was higher compared to layer litter; wheat bran and wheat short (middling) but lower than Noug-seed cake and alfalfa. Teff straw was characterized by low CP (51 gm/kg DM) and high NDF (772gm/kg DM).

Table 8. Chemical composition of feed ingredients and the four dietary treatments.

Feed types	DM (g/kg)	Chemical composition (g/kg DM)					
		OM	CP	NDF	ADF	ADL	ASH
Layer litter	910	695	217	388	236	26	215
Alfalfa	908	807	229	342	309	46	101
Noug cake	920	800	280	282	221	91	120
Teff straw	920	843	51	772	466	42	77
Wheat bran	900	843	142	522	156	32	57
Wheat middling's (short)	880	839	152	360	134	20	41
D. Treat.1(0% Layer litter)	910	844	186	538	110	22	66
D. Treat. 2(5% Layer litter)	910	842	180	530	115	34	68
D. Treat. 3(10% Layer litter)	910	837	171	480	114	31	73
D. Treat.4(15% Layer litter)	910	831	175	512	105	22	79

D.Treat.: dietary treatment; DM: dry matter; OM: organic matter; CP: crude protein; NDF: neutral detergent; ADF: acid detergent fiber; ADL: acid detergent lignin;

Layer litter were mixed at different levels with concentrate across all the treatments and resulted higher OM, CP, NDF than layer litter alone but higher ADF, DM content observed in poultry litter alone than treatment feeds (Table.8) poultry litter was mixed with concentrate at 0%, 5% and 10%,15% of the animals daily dry matter ration. Dietary treatment with 5% and 10% poultry litter showed higher ADL than layer litter alone and dietary treatment with 15 poultry litter. Ash content of dietary treatments was lower compared to layer litter alone. CP, OM, NDF contents of the dietary treatment without poultry litter was higher than the rest dietary treatments containing poultry litter at varying proportions. Dietary treatment with 15% layer litter has ash content than other dietary treatments. ADF was in highest concentration in dietary treatment with 5% layer litter.

4.3. Feed Intake

Table 9 presents the dry matter and other nutrients' intake levels of the four dietary treatments. There was no significant difference among the dietary treatments in intake levels of straw dry matter ($p=0.4373$), straw organic matter ($p=0.5073$), straw fiber fractions ($p=0.4215$, 0.2794) with exception to straw acid detergent lignin ($p<0.0001$). Among the dietary treatments containing varying levels of layer litter, there appeared to be an increase in straw dry matter and organic matter intake with increased rates of poultry litter; however the result was not statistically significant. A significant ($p=0.0076$) straw crude protein intake was noted with higher values (10% and 15%) layer litter incorporation. Total dry matter ($p=0.1845$) and organic matter intakes ($p=0.9255$) were not significantly different among dietary treatments.

Intakes of crude protein and ash were higher ($p<0.0001$) in dietary treatments containing layer litter than the one without. Intake of fiber fractions (except acid detergent fiber) were reduced significantly ($p < 0.0001$) with increased level of layer litter incorporation. Dry matter and nutrients intakes were significantly different within dietary treatments when observed across the different feeding periods.

Table 9. Feed intake (kg/day) of lactating cows supplemented with concentrate containing layer litter.

Feed contents	Dietary treatments					p-value		Covariance estimate	
	DT1	DT2	DT3	DT4	SE	Treat.	Period	Cow(Seq.)	Residual
SDMI	8.330	8.275	8.296	8.331	0.2344	0.4373	0.0013	0.4325	0.2062
SOMI	7.002	6.962	6.980	7.010	0.2015	0.5073	0.0012	0.3198	0.1526
SCPI	0.445 ^b	0.445 ^b	0.448 ^a	0.446 ^b	0.0059	0.0076	0.0002	0.0003	0.0001
SAshI	0.661 ^a	0.651 ^b	0.652 ^b	0.654 ^b	0.0141	0.0001	0.0017	0.0016	0.0007
SNDFI	6.4274	6.3848	6.3968	6.426	0.1823	0.4215	0.0013	0.2617	0.1247
SADFI	3.8843	3.8527	3.8622	3.8780	0.1050	0.2794	0.0013	0.0869	0.0414
SADLI	3.6552 ^a	3.5773 ^c	3.5568 ^c	3.6035 ^b	0.0701	<.0001	0.0008	0.0387	0.0188
TDMI	16.424	16.457	16.478	16.513	0.2309	0.1845	<.0001	0.4190	0.2197
TOMI	13.702	13.724	13.719	13.722	0.1987	0.9255	<.0001	0.3104	0.1612
TCPI	1.382 ^b	1.395 ^a	1.384 ^b	1.396 ^a	0.0062	<.0001	<.0001	0.0003	0.0009
TashI	1.319 ^d	1.327 ^c	1.351 ^b	1.380 ^a	0.0138	<.0001	<.0001	0.0015	0.0009
TNDFI	10.102 ^a	10.0385 ^{bc}	9.8230 ^d	9.9985 ^c	0.1817	<.0001	0.0010	0.2598	0.1261
TADFI	5.49358	5.49825	5.50326	5.47809	0.1045	0.5944	0.0008	0.0859	0.0424
TADLI	3.92041 ^a	3.8991 ^a	3.8649 ^b	3.8706 ^b	0.0700	<.0001	0.0006	0.0386	0.0188

SDMI=straw dry matter intake; SOMI=straw organic matter intake; SCPI=straw crude protein intake; SAshI=straw ash intake; SNDFI=straw neutral detergent intake; SADFI=straw acid detergent intake; SADLI=straw acid detergent lignin intake; TDMI=total organic matter intake; TOMI=total organic matter intake; TCPI=total crude protein intake; TashI=total ash intake; TNDFI=total neutral detergent intake; TADFI=total acid detergent intake; TADLI=total acid detergent lignin intake. Similar letters across a given row denote no significance difference among treatments ($p>0.05$).

4.4. Milk yield and milk composition

The effect of layer litter inclusion in the diets of dairy cows on milk yield, milk components yield and percentage are presented in table 10. Mean daily milk yield was increased at 10% inclusion level of poultry litter. Milk components percentage and daily yield also varied between the dietary treatments. Increased level of layer litter inclusion however appeared to have depressed fat percentage ($p<0.05$) but SNF and protein percentages didn't show significant change. Daily

yield of fat protein and SNF showed significant variability between the dietary treatments. Protein and SNF yields were highest at 10% inclusion levels of layer litter while that of fat was adversely affected.

Table 10. Effects of dietary treatments on daily milk yield, milk components yield and milk components percentage.

	Dietary treatments					p-value		Covariance estimate	
	DT1	DT2	DT3	DT4	Se	Treat	Period	Cow(seq.)	Residual
Daily milk yield(kg/day)									
Am	5.02 ^b	5.01 ^b	5.12 ^a	5.01 ^b	0.32	0.0512	<.0001	0.80	0.26
Pm	2.96	2.95	2.98	2.97	0.23	0.8938	<.0001	0.41	0.16
Day total	7.97	7.96	8.09	7.98	0.54	0.1086	<.0001	2.35	0.48
Milk Composition%									
Fat	3.97	3.96	3.80	3.96	0.18	0.5791	0.0133	0.18	0.16
SNF	8.99	8.96	8.95	8.95	0.12	0.8467	0.0029	0.09	0.03
Protein	3.16	3.13	3.14	3.14	0.045	0.7807	0.0027	0.014	0.01
Physical property of milk(gm/cm ³) FP (°C)									
Density	1.0260	1.0267	1.0269	1.0266	0.36	0.7221	0.0038	0.95	0.23
FP	-0.53	-0.54	-0.55	-0.54	0.65	0.8853	0.0015	2.98	0.91
Milk component yield(g/day) ¹									
FAT	312.9 ^a	314.5 ^a	304.8 ^b	309.3 ^b	16.47	0.0020	<.0001	2.14	0.89
Protein	251.0 ^b	249.0 ^b	253.9 ^a	249.5 ^b	15.67	0.0520	<.0001	1.95	0.464
SNF	715.7	712.0	724.4	711.7	45.17	0.0840	<.0001	16.20	3.75

Am= morning milk yield; pm= evening milk yield; SNF=solid not fat; ¹calculated as, composition yield= composition percentage *milk yield. Similar letters across a given row denote no significance difference among treatments (p>0.05).

Compared to the dietary treatment with out layer litter, fat yield was reduced by 2.6% (312.9 to 304.8 g/day) in D.T.3 and by 1.2 % (312.9 to 309.3 g/day) in D.T.4.

Substitution of noug seed cake portion of a concentrate with layer litter at 10% level significantly increased ($p<.0001$) protein yield. SNF yield of milk was also showed an increase at the above indicated level of inclusion of layer litter. Milk yield, milk composition and composition yields were varied within dietary treatments across the four feeding periods.

4.5 Correlation among parameters

A significant ($P<.0001$) and highly positive correlations were observed between TDMI and TCPI, TashI, Tmlkyld, Tfatyld, TSNFyld and TMProYld. However, compared to the relation to other parameters diet TCPI is relatively less correlated with total milk yield ($r=0.0899$; $P=0.0055$), solid not fat yield and total milk protein yield ($r=0.097$, 0.0998 ; $P=0.0021$).

Table 11. Pearson correlation coefficients among some parameters

	TDMI	TOMI	TCPI	TashI	Tmlkyld	Tfatyld	TSNFyld
TOMI	0.9994***						
TCPI	0.6287***	0.6174***					
TashI	0.9026***	0.8867***	0.6784***				
Tmlkyld	0.3704***	0.3721***	0.0899**	0.3171***			
Tfatyld	0.3831***	0.3850***	0.1882***	0.3210***	0.8181***		
TSNFyld	0.3941***	0.3961***	0.0997*	0.3341***	0.9892***	0.8711***	
TMProYld	0.3947***	0.3966***	0.0998*	0.3351***	0.9867***	0.8778***	0.9998***

Where, ***= $P<.0001$; **= $P=0.0055$; *= $P=0.0021$ TOMI=total organic matter intake; TCPI=total crude protein intake;

TashI=total ash intake; Tmlkyld=total milk yield; Tfatyld= total fat yield; TSNFyld= total solid not fat yield;

TMproYld=total milk protein yield; TDMI= total dry matter

5. DISCUSSION

5.1 Chemical composition of the dietary treatments

The CP content of noug seed cake used in this experiment was 28% and it's lower than 35.3% and its ash content 12% was higher than 7.4% reported by (Hadjipanayiotou 1984). These differences may be due to the method of extraction employed, which creates differences in chemical composition of oil seed cakes (McDonald *et al.*, 2002). The CP content of the layer litter used in this study was similar to that reported for layers litter (Hadjipanayiotou 1984), however, it was lower than the CP content of 30.3% (Yoseph *et al.*, 2002), and 27.8% (Deshck *et al.*, 1998), and also 24.5% reported by Bakshi and Fontenot (1998). Many factors could contribute to the observed differences in CP content of layer litter which include methods of processing (Bakshi and Fontenot 1998), types of bedding material (Bhattacharya and Taylor, 1975), the proportion of excreta in the litter and the environmental conditions under which the manure was conserved (Cullison *et al.*, 1976). Generally, the observed CP content of layer litter used in this study was more than adequate for supplementing animals fed low CP containing feeds.

Layer litter contained higher ash than noug seed cake, wheat bran and wheat middlings. This could be attributed to higher digestibility of organic matter (OM) in poultry diets, thus raising the proportion of inorganic matter in poultry litter. The ash content of layer litter in this experiment was equal with 21.5% reported by Hadjipanayiotou (1984), but was higher compared to 17.6% (Tsadik *et al.*, 2008). McDonald *et al.*, (2002) indicated that other things being equal, the higher the level of ash in feed samples, the lower will be its energy value. Therefore, the results suggested the energy value of layer litter to be lower than that of noug seed cake as well as wheat bran and wheat middlings. The CP content of teff straw used in this experiment was 5.1% which is higher than 4.2% reported by (Melaku *et al.*, 2005) but lower ADL & OM.

Tef straw is characterized by low CP (51 gm/kg DM) and high NDF (772 gm/kg DM) , which are typical features of most cereal crop residues and this is in consistence with Van Soest (1994) report that ADL and ADF are related more to digestibility than to intake, whereas the reverse is a characteristic feature of protein contents .

5.2 Feed intake

In the present study, there were no statistically significant differences in dry matter and organic matter intakes among the four dietary treatments indicating that inclusion of layer litter in the diet of dairy cows did not depress palatability. This result is in agreement with the reports of other authors. Silva, et al. (1976) reported absence of depression in feed intake of lactating cows fed with a ration composed of dried poultry waste for up to 10%. Talib and Ahmed, (2008) who did experiments on sheep and goats also reported no effect of poultry litter inclusion on feed intake. Arave et al. (1990) reported that lactating dairy cows fed up to 17.4% (of total mixed ration) processed poultry waste were not depressed in diet dry matter intake. Contrary to the present study, research works by Abdul et al (2008) on supplementation of 0.5 and 1 kg of dried poultry litter to cattle fed on sorghum Stover resulted in a significant improvement in feed intake. Harmon *et al.* (1975) showed that the voluntary dry matter intake was highest for silage containing broiler litter than for control and urea silages. Average daily dry matter consumption was 848g for the control silage and 925g for urea treated silage and 1445 and 1464g for silage containing 50 and 30% broiler litter on dry matter basis, respectively. Abdelmawla et al., (1988) reported that apparent digestibility of dry matter and crude protein, and nitrogen utilization by sheep fed composted litter was similar to those for sheep fed deep-stacked litter.

Similar with the present study (Elashry et al., 1994) reported that Both feed intake and milk production in ewes and buffaloes was not affected by the inclusion of 14% Poultry Waste as a dietary supplement. This is a clear indication that cottonseed meal, nougcake and other high protein feed ingredients could be, at least partially replaced, by Poultry Waste without any loss in productivity.

5.3. Milk yield and composition

The present study also showed some influence of layer litter feeding on daily milk yield and milk components yield. Layer litter inclusion level of 10% was found to have beneficial effect on milk, SNF and protein yield while fat was slightly depressed. Bull and Reid, (1971) reported that feeding dried caged layer waste had no adverse effect on milk yield and milk quality which is comparable with the present result. On the other hand Arave et al. (1990) reported that lactating dairy cows fed on diets containing processed poultry waste had no effect on milk and fat yields.

Studies by Smith and Wheeler (1979) also confirmed no difference in milk yield, while Silva et al., (1976) observed a decrease in milk yield of lactating cows fed higher rates (20 to 30% of ration) of poultry wastes and recommended 10% of the waste inclusion which is in agreement to the present result.

Hadjipanayiotou. (1993), reports also showed that, goats on the poultry manure diet produces significantly more milk (621 vs 558g/d) compared to those on the concentrate diet. Feeding a diet containing dried poultry waste to dairy cows did not significantly affect lead, zinc and tocopheral in milk (Bruhn et al., 1977).

Overall flavor quality scores were similar for milk from cows fed 0, 10, 20 or 30% poultry waste. Flavor of milk from dairy cows fed a diet containing dried layer waste was similar to that of cows fed diets not containing waste (Thomas et al., 1972).

5.4. Feed cost

During the study period the cost of unprocessed and processed poultry litters were lower by 75% and 32%, respectively compared to that of Noug seed cake. Thirty percent of the surveyed producers also indicated decrease in feed cost as one of the advantages of using poultry litter as milking cows feed ingredient. Adegbola et al., 1985; Nwogu et al., 2003, reported that increasing cost of conventional protein is major factor led to intensive use of unconventional feed resources non-protein nitrogen (poultry litter) for most small holder farmers.

6. CONCLUSION AND RECOMMENDATIONS

The use of poultry litter as animal feed ingredient is a frequently encountered practice in Debre Zeit area. Producers mentioned increased milk yield and decreased feed cost as a benefit from using poultry litter as concentrate feed ingredient. The results of this study also showed that the chemical composition of layer litter is not much different from that of Noug seed cake; the feed ingredient that the layer litter is said to have the potential to replace in the concentrate mixture. The inclusion of layer litter at 5, 10 and 15% in the concentrate mixture had no any significant effect on dry matter intake. Ten percent inclusion level of layer litter was found to have highest positive effect on milk, protein and solid not fat yields compared to the 5 and 15% inclusion levels. The cost of poultry litter was nearly one third of that of Noug seed cake. Thus, poultry feed use might allow a combination of decreased costs and improved production that could be translated into significantly improved profitability.

In line with the above conclusion the following recommendations are forwarded:

- The findings of the present study revealed that 10% inclusion level of layer litter in concentrate mixture has the potential to replace Noug cake that allows to improve efficiencies and to increase income.
- Work needs to be extended to include chemical analysis of poultry litter from different farms in order to get more comprehensive chemical characterization of poultry litter.
- Extension works to introduce poultry litter as feed ingredient to dairy cows in other potential dairy farming areas should be sought.
- Further study that includes large number of small holder farmers and looks into improved ways of processing poultry litter are required.

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8. APPEDINXS

Appendix 1 Analysis of variance table of daily total straw dry matter intake(g)

Effect	Num DF	Den Df	F value	Prob>F
Treatment	3	937	0.91	0.4373
Period	3	937	5.30	0.0013

Appendix 2 Analysis of variance table of daily total straw OM intake (g)

Effect	Num DF	Den Df	F value	Prob>F
Treatment	3	937	0.78	0.5073
Period	3	937	5.32	0.0012

Appendix 3. Analysis of variance table of daily total straw CP intake (g)

Effect	Num DF	Den Df	F value	Prob>F
Treatment	3	937	4.00	0.0076
Period	3	937	6.58	0.0002

Appendix 4 Analysis of variance table of daily total straw Ash intake (g)

Effect	Num DF	Den Df	F value	Prob>F
Treatment	3	937	6.97	0.0001
Period	3	937	5.08	0.0017

Appendix 5. Analysis of variance table of total DM intake (g)

Effect	Num DF	Den Df	F value	Prob>F
Treatment	3	937	1.61	0.1845
Period	3	937	7.59	<.0001

Appendix 6. Analysis of variance table of total OM intake (g)

Effect	Num DF	Den Df	F value	Prob>F
Treatment	3	937	0.16	0.9255
Period	3	937	7.34	<.0001

Appendix 7. Analysis of variance table of total CP intake (g)

Effect	Num DF	Den Df	F value	Prob>F
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Treatment	3	937	14.27	<.0001
Period	3	937	25.23	<.0001

Appendix 8 Analysis of variance table of total Ash intake (g)

Effect	Num DF	Den Df	F value	Prob>F
Treatment	3	937	202.79	<.0001
Period	3	937	11.24	<.0001

ANOVA table of fiber intake

Appendix 9. Analysis of variance table of STNDF intake (g)

Effect	Num DF	Den Df	F value	Prob>F
Treatment	3	937	0.94	0.4215
Period	3	937	5.26	0.0013

Appendix 10. Analysis of variance table of STADF intake (g)

Effect	Num DF	Den Df	F value	Prob>F
Treatment	3	937	1.28	0.2794
Period	3	937	5.29	0.0013

Appendix 11. Analysis of variance table of STADL intake (g)

Effect	Num DF	Den Df	F value	Prob>F
Treatment	3	937	23.38	<.0001
Period	3	937	5.61	0.0008

Appendix 12. Analysis of variance table of total NDF intake (g)

Effect	Num DF	Den Df	F value	Prob>F
Treatment	3	937	27.19	<.0001
Period	3	937	5.43	0.0010

Appendix 13 .Analysis of variance table of total ADF intake (g)

Effect	Num DF	Den Df	F value	Prob>F
Treatment	3	937	0.63	0.5944
Period	3	937	5.63	0.0008

Appendix 14 .Analysis of variance table of total ADL intake (g)

Effect	Num DF	Den Df	F value	Prob>F
Treatment	3	937	8.60	<.0001
Period	3	937	5.85	0.0006

Appendix 15. Analysis of variance of daily AM Milk yield

Effect	Num DF	Den Df	F value	Prob>F
Treatment	3	938	2.60	0.0512
Period	3	938	214.88	<.0001

Appendix 16. Analysis of variance of daily PM milk yield

Effect	Num DF	Den Df	F value	Prob>F
Treatment	3	938	0.20	0.8938
Period	3	938	213.58	<.0001

Appendix 17. Analysis of variance table of daily TOTAL milk yield

Effect	Num DF	Den Df	F value	Prob>F
Treatment	3	938	2.03	0.1086
Period	3	938	365.77	<.0001

ANOVA table of milk composition (%)**Appendix 18. Analysis of variance table of density (%)**

Effect	Num DF	Den Df	F value	Prob>F
Treatment	3	50	0.44	0.7221
Period	3	50	5.08	0.0038

Appendix 19. Analysis of variance table of protein (%)

Effect	Num DF	Den Df	F value	Prob>F
Treatment	3	50	0.99	0.4035
Period	3	50	0.93	0.4350

Appendix 20. Analysis of variance table of FP (%)

Effect	Num DF	Den Df	F value	Prob>F
Treatment	3	50	0.22	0.8853
Period	3	50	5.98	0.0015

Appendix 21. Analysis of variance table of FAT (%)

Effect	Num DF	Den Df	F value	Prob>F
Treatment	3	50	0.66	0.5791
Period	3	50	3.95	0.0133

Appendix 22. Analysis of variance table of SNF (%)

Effect	Num DF	Den Df	F value	Prob>F
Treatment	3	50	0.27	0.8467
Period	3	50	5.31	0.0029

Table presenting difference of least squares means

Appendix 23. Differences of Least Squares Means for STDMI

Effect	TREAT	TREAT	Standard Error	t Value	Pr > t
TREAT	1	2	0.04164	1.37	0.1725
TREAT	1	3	0.04164	0.85	0.3970
TREAT	1	4	0.04168	-0.00	0.9975
TREAT	2	3	0.04164	-0.52	0.6047
TREAT	2	4	0.04169	-1.37	0.1721
TREAT	3	4	0.04168	-0.85	0.3957

N.B. P=0.05, DF=937

Appendix 24. Differences of Least Squares Means for STOMI

Effect	TREAT	TREAT	Standard Error	t Value	Pr > t
TREAT	1	2	0.03581	1.17	0.2436
TREAT	1	3	0.03582	0.65	0.5153
TREAT	1	4	0.03585	-0.20	0.8445
TREAT	2	3	0.03581	-0.52	0.6061
TREAT	2	4	0.03586	-1.36	0.1737
TREAT	3	4	0.03585	-0.85	0.3975

N.B. P=0.05, DF=937

Appendix 25. Differences of Least Squares Means for SCPI

Effect	TREAT	TREAT	Standard Error	t Value	Pr > t
TREAT	1	2	0.001074	0.17	0.8676
TREAT	1	3	0.001075	-2.89	0.0039
TREAT	1	4	0.001076	-1.23	0.2206
TREAT	2	3	0.001074	-3.06	0.0023
TREAT	2	4	0.001076	-1.39	0.1642
TREAT	3	4	0.001076	1.67	0.0961

N.B. P=0.05, DF=937

Appendix 26. Differences of Least Squares Means for SAsHl

Effect	TREAT	TREAT	Standard Error	t Value	Pr > t
TREAT	1	2	0.002503	4.20	<.0001
TREAT	1	3	0.002504	3.66	0.0003
TREAT	1	4	0.002506	2.76	0.0059
TREAT	2	3	0.002503	-0.54	0.5866
TREAT	2	4	0.002506	-1.44	0.1513
TREAT	3	4	0.002506	-0.89	0.3721

N.B. P=0.05, DF=937

Appendix 27. Differences of Least Squares Means for TDMI

Effect	TREAT	TREAT	Standard Error	t Value	Pr > t
TREAT	1	2	0.04298	0.4504	0.4504
TREAT	1	3	0.04299	0.2026	0.2026
TREAT	1	4	0.04303	0.0329	0.0329
TREAT	2	3	0.04298	0.6029	0.6029
TREAT	2	4	0.04304	0.1672	0.1672
TREAT	3	4	0.04303	0.3884	0.3884

N.B. P=0.05, DF=937

Appendix 28. Differences of Least Squares Means for TOMI

Effect	TREAT	TREAT	Standard Error	t Value	Pr > t
TREAT	1	2	0.03682	-0.58	0.5652
TREAT	1	3	0.03682	-0.48	0.6337
TREAT	1	4	0.03686	-0.60	0.5511
TREAT	2	3	0.03682	0.10	0.9216
TREAT	2	4	0.03687	-0.02	0.9827
TREAT	3	4	0.03686	-0.12	0.9044

N.B. P=0.05, DF=937

Appendix 29. Differences of Least Squares Means for TCPI

Effect	TREAT	TREAT	Standard Error	t Value	Pr > t
TREAT	1	2	0.002839	-4.74	<.0001
TREAT	1	3	0.002839	-1.15	0.2488
TREAT	1	4	0.002842	-5.47	<.0001
TREAT	2	3	0.002839	3.58	0.0004
TREAT	2	4	0.002842	-0.73	0.4644
TREAT	3	4	0.002842	-4.31	<.0001

N.B. P=0.05, DF=937

Appendix 30. Differences of Least Squares Means for TAshI

Effect	TREAT	TREAT	Standard Error	t Value	Pr > t
TREAT	1	2	0.002750	-2.77	0.0058
TREAT	1	3	0.002750	-11.56	<.0001
TREAT	1	4	0.002753	-22.34	<.0001
TREAT	2	3	0.002750	-8.80	<.0001
TREAT	2	4	0.002753	-19.58	<.0001
TREAT	3	4	0.002753	-10.79	<.0001

N.B. P=0.05, DF=937

Appendix 31. Differences of Least Squares Means for STNDFI

Effect	TREAT	TREAT	Standard Error	t Value	Pr > t
TREAT	1	2	0.03238	1.38	0.1689
TREAT	1	3	0.03239	1.00	0.3170
TREAT	1	4	0.03242	0.07	0.9474
TREAT	2	3	0.03238	-0.38	0.7073
TREAT	2	4	0.03242	-1.31	0.1980
TREAT	3	4	0.03241	-0.93	0.3504

N.B. P=0.05, DF=937

Appendix 32. Differences of Least Squares Means for STADFI

Effect	TREAT	TREAT	Standard Error	t Value	Pr > t
TREAT	1	2	0.01865	1.76	0.0784
TREAT	1	3	0.01865	1.24	0.2151
TREAT	1	4	0.01867	0.38	0.7015
TREAT	2	3	0.01865	-0.52	0.6022
TREAT	2	4	0.01867	-1.38	0.1690
TREAT	3	4	0.01867	-0.86	0.3922

N.B. P=0.05, DF=937

Appendix 33. Differences of Least Squares Means for STADLI

Effect	TREAT	TREAT	Standard Error	t Value	Pr > t
TREAT	1	2	0.01256	6.28	<.0001
TREAT	1	3	0.01257	7.90	<.0001
TREAT	1	4	0.01258	4.17	<.0001
TREAT	2	3	0.01256	1.62	0.1047
TREAT	2	4	0.01258	-2.11	0.0353
TREAT	3	4	0.01258	-3.73	0.0002

N.B. P=0.05, DF=937

Appendix 34. Differences of Least Squares Means for TNDFI

Effect	TREAT	TREAT	Standard Error	t Value	Pr > t
TREAT	1	2	0.03257	2.02	0.0439
TREAT	1	3	0.03257	8.62	<.0001
TREAT	1	4	0.03260	3.21	0.0014
TREAT	2	3	0.03256	6.61	<.0001
TREAT	2	4	0.03261	1.20	0.2317
TREAT	3	4	0.03260	-5.40	<.0001

N.B. P=0.05, DF=937

Appendix 35. Differences of Least Squares Means for TADFI

Effect	TREAT	TREAT	Standard Error	t Value	Pr > t
TREAT	1	2	0.01888	-0.20	0.8451
TREAT	1	3	0.01889	-0.48	0.6343
TREAT	1	4	0.01890	0.83	0.4059
TREAT	2	3	0.01888	-0.28	0.7791
TREAT	2	4	0.01891	1.03	0.3049
TREAT	3	4	0.01890	1.31	0.1916

N.B. P=0.05, DF=937

Appendix 36. Differences of Least Squares Means for TADLI

Effect	TREAT	TREAT	Standard Error	t Value	Pr > t
TREAT	1	2	0.01258	1.77	0.0772
TREAT	1	3	0.01258	4.47	<.0001
TREAT	1	4	0.01259	3.99	<.0001
TREAT	2	3	0.01258	2.71	0.0069
TREAT	2	4	0.01260	2.22	0.0263
TREAT	3	4	0.01259	-0.48	0.6330

N.B. P=0.05, DF=937

Appendix 37. Differences of Least Squares Means for daily milk (Am)

Effect	TREAT	TREAT	Standard Error	t Value	Pr > t
TREAT	1	2	0.04649	0.34	0.7323
TREAT	1	3	0.04650	-2.06	0.0394
TREAT	1	4	0.04649	0.25	0.8022
TREAT	2	3	0.04649	-2.41	0.0164
TREAT	2	4	0.04650	-0.09	0.9270
TREAT	3	4	0.04649	2.31	0.0209

N.B. P=0.05, DF=937

Appendix 38. Differences of Least Squares Means for daily milk (Pm)

Effect	TREAT	TREAT	Standard Error	t Value	Pr > t
TREAT	1	2	0.03669	0.54	0.5879
TREAT	1	3	0.03669	-0.19	0.8492
TREAT	1	4	0.03669	-0.03	0.9733
TREAT	2	3	0.03669	-0.73	0.4642
TREAT	2	4	0.03669	-0.58	0.5652
TREAT	3	4	0.03669	0.16	0.8755

N.B. P=0.05, DF=937

Appendix 39. Differences of Least Squares Means for daily milk (total)

Effect	TREAT	TREAT	Standard Error	t Value	Pr > t
TREAT	1	2	0.06346	0.23	0.8205
TREAT	1	3	0.06347	-1.96	0.0499
TREAT	1	4	0.06346	-0.15	0.8813
TREAT	2	3	0.06346	-2.19	0.0287
TREAT	2	4	0.06347	-0.38	0.7068
TREAT	3	4	0.06346	1.81	0.0700

N.B. P=0.05, DF=937

Appendix 40. Differences of Least Squares Means for FAT

Effect	TREAT	TREAT	Standard Error	t Value	Pr > t
TREAT	1	2	0.1431	0.11	0.9135
TREAT	1	3	0.1431	1.21	0.2305
TREAT	1	4	0.1431	0.09	0.9273
TREAT	2	3	0.1431	1.10	0.2745
TREAT	2	4	0.1431	-0.02	0.9861
TREAT	3	4	0.1431	-1.12	0.2671

N.B. P=0.05, DF=937

Appendix 41. Differences of Least Squares Means for SNF

Effect	TREAT	TREAT	Standard Error	t Value	Pr > t
TREAT	1	2	0.06114	0.63	0.5291
TREAT	1	3	0.06114	0.71	0.4838
TREAT	1	4	0.06114	0.82	0.4173
TREAT	2	3	0.06114	0.07	0.9432
TREAT	2	4	0.06114	0.18	0.8547
TREAT	3	4	0.06114	0.11	0.9109

N.B. P=0.05, DF=937

Appendix 42. Differences of Least Squares Means for PROTINE

Effect	TREAT	TREAT	Standard Error	t Value	Pr > t
TREAT	1	2	1.2380	0.02	0.9848
TREAT	1	3	1.2380	-1.40	0.1638
TREAT	1	4	1.2380	0.02	0.9876
TREAT	2	3	1.2380	-1.42	0.1626
TREAT	2	4	1.2380	-0.00	0.9972
TREAT	3	4	1.2380	1.41	0.1637

N.B. P=0.05, DF=937

Appendix 43. Differences of Least Squares Means for DENSITY

Effect	TREAT	TREAT	Standard Error	t Value	Pr > t
TREAT	1	2	0.1681	0.67	0.5065
TREAT	1	3	0.1681	0.19	0.8533
TREAT	1	4	0.1681	1.04	0.3029
TREAT	2	3	0.1681	-0.48	0.6310
TREAT	2	4	0.1681	0.37	0.7117
TREAT	3	4	0.1681	0.86	0.3966

N.B. P=0.05, DF=937

Appendix 44. Differences of Least Squares Means for FP

Effect	TREAT	TREAT	Standard Error	T Value	Pr > t
TREAT	1	2	0.3380	0.72	0.4742
TREAT	1	3	0.3380	0.35	0.7268
TREAT	1	4	0.3380	0.65	0.5205
TREAT	2	3	0.3380	-0.37	0.7131
TREAT	2	4	0.3380	-0.07	0.9413
TREAT	3	4	0.3380	0.30	0.7686

Appendix for questionnaire format

Appendix 45. Questioners about the use of poultry litter as animal feed.

Questionnaire code

Date data collected.....

Name of data collector.....

A) General information

1) Farmer name

2) Sex a) male b) female

3) Age

4) Educational status

a) 1st degree & above

b) Diploma

c) Certificate

d) High school

e) Primary school

f) Illiterate

5) Occupational status

a) Governmental

b) NGO

c) Investor

d) Hired by others

e) Daily laborer

f) If other specify

6) Main source of income

a) monthly salary

b) livestock production

c) crop production

d) merchant (business)

e) a&b

f) a&c

g) If other, specify.....

B) Production type

7) Type & No of milking and dried cows

Appendix 46: Type & No of milking and dried cows

Type of animal	Milking cows	Dried cows
No		

C) Feed utilization

8) What is the main feed type used for dairy cows?

a) Tefstraw b) Hay c) Oat d) Straw e) other.....

9) Supplementary feeds given in addition with main feed

Appendix 46: Supplementary feeds given in addition with main feed

	Please mark ()
Supplementary feed types	
Alfalfa	
Concentrate	
Mineral block	
Urea molasses block	
Vitamin supplements	
Other green forages & legumes (e.g. elephant grass)	
Silage	
Stover	
Maize	
Others	

10) How does u find concentrate?

- a) Purchase b) home preparation

11) Type & amount of concentrate ingredients

Appendix 47: Type & amount of concentrate ingredients

Ingredient type	Amount (in hundred)

12) Do you use poultry litter as animal feed?

- a) Yes b) No i don't use

13) If your answer is no, why?

- a) Not available in market b) its expensive c) Not interested

- d) I don't know its use e) it gives milk abnormal odor

- f) Cows not feed (ingest) g) other

14) If your answer is yes, how does u use it?

- a) Inclusion (mixed) in concentrate feeds b) feed poultry litter alone

15) If mixed in concentrate, its proportion (in hundred)%

16) When u give poultry litter and when u give concentrate feed having poultry litter?

- a) At the morning before milking e) At the evening before milking

- b) At the morning during milking f) At evening during milking

- c) At the morning after milking g) At evening after milking

- d) At noon (at lunch time)

17) When u use poultry litter, which kind?

- a) Poultry litter alone b) poultry litter with dust with other feed staff

18) If u use poultry litter from market how much is it price per kg/quintal?

Per kg..... birr per quintal..... birr

19) What is the advantage u gain by using poultry litter for milking cow?

- a) Increase milk production
- b) Improve milk production quality
- c) Increase both milk production& milk quality
- d) Decrease feed cost that is used for milking cow
- e) In addition to increasing milk production& milk quality it decrease the feed cost.
- f) It keeps the animal healthy
- g) I gain no benefits from using poultry litter

20) Describe the improvement in milk production quality by using poultry litter?

- a) Flavor becomes good c) it gives the milk good color
- b) The taste becomes good d) other.....

21) If milk yield is increases using poultry litter how much is its increment daily milk average/cow/liter? Liter

22) Does the milk u produce using poultry litter return from the cooperative due to the milk is not fit for the market ?

- a) Yes b) No, it's never return

23) If your answer is yes what measure does u take?

- a) Stop using poultry litter b) keep using poultry litter by changing the method

24) Is there any health problem encounter by using poultry litter?

- a) Yes b) no health problem

25) Is there any training u get about poultry litter use and also how to use it?

- a) Yes
- b) no, I didn't get any training

26) If your answer is yes where does u get the training?

27) What is your general comment concerning poultry litter as animal feed?

9. CURRICULUM VITEA

A: personal details

Name	Netsanet Ayalew
Date of birth	July14, 1984.
Place of birth	A.A , Ethiopia
Marital status	Single
Nationality	Ethiopian
Profession	Animal production and Health
Occupation	Student

B. Educational background

Year	School Attended
2004/5-2006/7	MeizaElmentary school, Addis Ababa
2000/01-2001/02	Higher 12 Senior secondary school, Addis Ababa
2002/03-2003/04	Yekatit12 (menen) High school, A.A, Ethiopia
2004/05-2006/7	Jimma University, Ambo College of Agriculture, Ambo, Ethiopia

10. SIGNED DECLARATION SHEET

The thesis, my original work, has not been presented for a degree in any other university and that all sources of material used for the thesis have been duly acknowledged.

Name _____

Signature _____

Date of submission _____

This thesis has been submitted for examination with our approval as University advisor.

Dr Mekonen Hailemariam _____

Prof. H Singh _____