

Research Article

Effects of Dandelion (*Taraxacum coreanum*) Supplementation on Milk Yield, Milk Compositions and Blood Characteristics in Lactating Dairy Cows

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ABSTRACT

This study aimed to investigate the effects of Dandelion (*Taraxacum coreanum*) supplementation on milk yield, milk composition and blood characteristics in lactating dairy cows. Eight lactating dairy cows were divided into two groups (control: TMR supplementation, treatment: TMR with Dandelion supplementation). The milk yield, milk fat, lactose, solids not fat (SNF) and somatic cells counts (SCC) were not significantly different between the control group and the treatment group, whereas milk protein, milk urea nitrogen (MUN) and free fat acid (FFA) were significantly higher in the treatment group compared to the control ($p < 0.05$). The blood components of the treatment group were compared with those of the control group and only aspartate aminotransferase (AST) appeared significantly high ($p < 0.05$). The other blood components were not significantly different in the two groups. Blood corpuscle components in the groups were not significantly different. Especially, all blood corpuscle components in the treatment group were within the normal range. However, the white blood cells (WBC), lymphocytes (LYM) and hematocrits (HCT) in the control group exceeded the normal range. Based on the above results, the addition of Dandelion to feed increased milk protein, MUN and FFA, but did not significantly affect the composition of the blood and corpuscle in Holstein milking cows. (**Key words** : Dandelion, Dairy cow, Milk compositions, Blood components)

I. INTRODUCTION

These days dairy industry has been focusing on the feeding and management of the high yielding dairy cows with high milk yield and milk fat percentage in order to improve economic income. It leads to the excessive concentrate feed of the high yielding dairy cows, causing many diseases including mastitis, liver disease, digestive tract diseases and deterioration of reproductive function (Kang et al., 2011; Lee et al., 1987; Lee et al., 2007). In particular, the mastitis that commonly occurs in high yielding dairy cows causes great economic losses to dairy farms, which therefore are devoting a lot of efforts for the prevention and cure of mastitis. However, the reduction of the somatic cells counts (SCC) is not satisfactory due to the lack of expertise of dairy farms in milking management methods for the prevention of mastitis and the unclear methods for treating mastitis. In addition, the reality is that they rely on large amounts of antibiotics, being aware of the dangers of super-bacteria caused by indiscriminate use of antibiotics (Kim et al., 2011). Many studies have been

carried out home and abroad on the mastitis therapy and the somatic cell count decrease, but they mostly rely on the preventive measures through feeding and management (Han et al., 2004.), environmental improvements (Kim et al., 2008; Kim et al., 2014) and antibiotics (Yoo et al., 2008a, b). Recently, however, research is performed on the methods to increase the productivity through the prevention and treatment of diseases of the livestock by using the medicinal plants (Oh et al., 2007; Park, et al.; 2010, Park and Kim, 2010; Kim and Choi, 2010). Among the medicinal plants, the pharmacological ingredients of Dandelion contains abundant bitter taste substances such as taraxacin and inulin; carotenoids such as taraxanthin; phytosterol such as taraxanol and taraxasterol; and phenolic compounds such as caffeic acid and chlorogenic acid (Katrin et al., 2006; Williams et al., 1996). Especially, leaves contain bitter taste components, polyphenols such as chlorogenic acid and chicoric acid, and flavonoids derivatives such as luteolin and quercetin; and flowers contain quercetin, luteolin and chicoric acid (Budzianowski et al., 1997; Williams et al., 1996). These components have been reported to have

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therapeutic effect of inflammation (Lee et al., 1993), antioxidation activity (Hu and Kitts, 2003; Kang et al., 2002), antimicrobial activity (Kim et al., 1998), anti-cancer and tumor activity suppression (Takasaki et al., 1999), HDL-cholesterol increase (Park et al., 2010), liver protection (You et al., 2010) and anti-inflammation effect (Jeon et al., 2008). This study aimed to evaluate the effect of Dandelion on the somatic cells counts (SCC), milk yield, milk compositions and blood characteristics in lactating dairy cows.

II. MATERIALS AND METHODS

1. Cows and diets

Eight Holstein dairy cows (2.5 parties, 55 months of age) were divided into two groups. The groups were allowed to 30 kg of TMR (control) and 30 kg of TMR with 100 g of Dandelion (treatment), respectively. The TMR was fed twice a day (08:00 and 20:00).

Water was allowed *ad libitum*. The first 3 weeks were for adaptation, and the final 3 weeks were used as the test period. The test was carried out at Yumyeog ranch located in Euncheok-myeon, Gyeongbuk. Table 1 shows the average body weight, average milk yield and milk compositions of the cows at the initial experiment. Dandelion was top-dressed in TMR. Dandelion-added feed was crushed and milled to mix well with TMR feed. Table 2 shows the chemical compositions of TMR and Dandelion used in the experiment. Dandelion was fed by top-dressing on TMR per 50 g (2

times per day). Blood and corpuscle components before testing are shown in Table 3 and 4.

2. Analysis

The samples were dried at 75°C for 72 hours to analysis. Nutrient analysis of feeds was performed by the AOAC method (1995). The ADF and NDF were determined by the procedure described by Goering and Van Soest (1970). And the crude protein was determined by the Kjeldahl procedure. The crude fat was determined by using a Soxhlet apparatus, and the crude ash was determined by incineration 550 °C. NFE was determined by subtracting crude protein, crude fat and crude ash from 100. Feed intake and milk yield were measured daily. Milk yield was measured using pipeline flow meters for milking (MM15, Delaval, Sweden). Milk composition were determined on individual samples that were collected weekly. The milk protein, milk fat, lactose, solid not fat (SNF), milk urea nitrogen (MUN), and free fatty acid (FFA) were measured by using Lact Scope FTIR Advanced (Dalta Instruments), and the somatic cells counts (SCC) was measure by using Soma Scope MK2 (Dalta Instruments).

Blood was collected two times in the morning (09:00) before and after the experiment. ① blood components analysis: 10cc of blood was collected from the intravenous in the neck of the dairy cow, followed by adding 0.1 cc of the blood in the dedicated reagent before analyzed by Vetscan VS2 (ABAXIS) auto blood analysis machine. ②

Table 1. Body weight, milk yield, milk compositions of dairy cows at the begging of experiment

Items	Control	Treatment
Initial body weight (kg)	557.5 ±15.2 ^{ns}	549.3 ±13.6
Yield of milk (kg)	21.67± 4.53 ^{ns}	20.23± 6.27
Compositions of milk		
fat (%)	4.13± 1.80 ^{ns}	4.62± 0.40
protein (%)	3.05± 0.03 ^{ns}	3.39± 0.19
lactose (%)	4.47± 0.14 ^{ns}	4.49± 0.15
solids not fat (SNF, %)	8.31± 0.13 ^{ns}	8.67± 0.33
milk urea nitrogen (MUN, %)	11.37± 1.01 ^{ns}	12.30± 2.50
free fat acid (FFA, mg/100g)	0.47± 0.45 ^{ns}	0.93± 0.45
somatic cells counts (SCC, 1,000/ml)	318.67± 67.65 ^{ns}	332.67±89.58

ns : not significant.

Table 2. The chemical compositions of the Dandelion and experimental diets

Items	Experimental diets (DM basis %)	
	TMR	Dandelion
Moisture(%)	34.37	10.30
Crude protein(%)	16.55	19.65
Crude fat (%)	4.10	1.57
Crude ash (%)	9.01	9.28
Crude fiber (%)	15.52	34.11
Nitrogen free extract (NFE, %)	54.82	35.38
Neutral detergent fiber (NDF, %)	42.79	41.19
Acid detergent fiber (ADF, %)	23.15	38.06
Total digested nutrient (TDN, %)	71.55	57.20
Metabolic energy (ME, Mcal/kg)	2.50	2.05
Net energy lactation (NEL, Mcal/kg)	1.64	1.31
Calcium (Ca, %)	0.81	1.28
Phosphorus (P, %)	0.48	0.28

Table 3. Blood compositions of dairy cows before experiment

Items	Control	Treatment
Albumin (ALB, g/dl)	3.7	4.1
Alkaline phosphatase (ALP, u/l)	68.3	57.0
Aspartate aminotransferase (AST, u/l)	71.0	78.3
Calcium (CA, g/dl)	9.9	10.4
γ -GTP gamma glutamyl transpetidase (GGT, u/l)	28.7	33.0
Total protein (TP, g/dl)	9.2	8.5
Globulin (GLOB, g/dl)	5.6	4.4
Blood Urea Nitrogen (BUN, mg/dl)	14.0	16.3
Creatine Kinase (CK, u/l)	155.0	275.7
Phosphate (P, mg/dl)	6.0	6.8
Magnesium (Mg, mg/dl)	2.2	2.3

blood corpuscle analysis: 10 cc of blood was collected from the intravenous in the neck of the dairy cow, followed by adding 0.025 cc of the blood in the dedicated reagent before analyzed by Vetscan HM2 (ABAXIS) blood corpuscle auto analysis machine.

Table 4. Blood corpuscle compositions of dairy cows before experiment.

Items	Controls	Treatment
White blood cell (WBC, $10^9/\ell$)	7.6	8.2
Lymphocyte (LYM, $10^9/\ell$)	5.6	6.0
Monocyte (MON, $10^9/\ell$)	0.7	0.8
Granulocyte (GRA, $10^9/\ell$)	1.3	1.4
Red blood cell (RBC, $10^{12}/\ell$)	5.3	6.3
Hemoglobin (HGB, g/l)	100.0	125.5
Hematocrit (HCT, %)	21.1	25.6
Mean corpuscular volume (MCV, fl)	41.5	40.0
Mean corpuscular hemoglobin (MCH, pg)	19.6	19.8
Mean corpuscular hemoglobin concentration (MCHC, g/l)	475.5	488.0
Red cell distribution width (RDWc, %)	25.0	27.5
Platelet count (PLT, $10^9/\ell$)	371.5	306.0
Platelet crit (PCT, %)	0.2	0.2
Mean platelet volume (MPV, fl)	6.4	6.4
Platelet distribution width (PDWc, %)	33.4	34.0

3. Statistics

Statistical analyses were performed by using the Statistical Analysis System (SAS release ver 9.1, 2002) for the significance ($p < 0.05$) differences between control and treatment by ANOVA and T-test.

III. RESULTS AND DISCUSSTION

1. Effects of the Dandelion added feed on the dry matter intake, milk yield and milk compositions

Table 5 shows the effects of the Dandelion added feed on the dry matter intake, milk yield and milk compositions. The average TMR intake was not the difference between the control (29.33 kg) and treatment (29.60 kg). This is because the feed was limited to 30 kg, which is eat enough for the control and treatment. The average milk yield and fat content did not show the significant difference between the control and treatment. While, the content of average

Table 5. Effects of Dandelion supplementation on dry matter intake, milk yield and milk compositions in lactating dairy cows.

Items	control				treatment			
	1 st week	2 nd week	3 rd week	Mean	1 st week	2 nd week	3 rd week	Mean
TMR intake (kg/day)	29.4	29.1	29.5	29.33±0.21 ^{ns}	29.4	29.5	29.8	29.6 ±0.21
Milk yield (kg)	17.60	19.13	18.53	18.42±0.77 ^{ns}	18.63	18.13	15.67	17.48±1.58
Fat (%)	4.08	4.72	3.83	4.21±0.46 ^{ns}	4.13	4.02	3.94	4.03±0.10
Protein (%)	2.96	2.95	3.06	2.99±0.06 ^b	3.42	3.36	3.30	3.36±0.06 ^a
Lactose (%)	4.30	4.26	4.37	4.31±0.06 ^{ns}	4.44	4.34	4.37	4.38±0.05
SNF (%)	8.03	7.98	8.20	8.07±0.12 ^{ns}	8.63	8.48	8.44	8.52±0.10
MUN (%)	12.53	11.43	12.07	12.01±0.55 ^b	14.67	14.57	14.20	14.48±0.25 ^a
FFA (mg/100g)	0.47	0.46	0.57	0.50±0.06 ^b	0.67	0.63	0.60	0.63±0.04 ^a
SCC (1,000/ml)	259.00	193.00	245.00	232.33±34.78 ^{ns}	273.00	246.00	230.00	249.66±21.73

^{a, b} Means in the same row with different letters were significantly different ($p < 0.05$).

ns : not significant.

milk protein showed significantly higher in the treatment (3.36%) than the control (2.99%) ($p < 0.05$). Lactose and SNF content were not the significant difference between control and treatment. The average MUN showed significantly higher in the treatment (14.48%) than the control (12.01%) ($p < 0.05$). In general, milk urea nitrogen (MUN) shows high value when the feed contains excess protein intake or low energy, and MUN shows low value when the energy is low or protein is lacking (Oltner and Wiktorsson, 1983; Roseler et al., 1993; Hof et al., 1997). The control in the experiment shows 12.01%, which falls in the range of MUN standard value of 12 mg/dl ~ 18 mg/dl (Moon et al., 2000, 2002), but may cause a variety of disease if dropped more. The MUN value under the standard level reduces milk yield, increases metabolic diseases such as ketosis and fatty liver, and delays the functionality recovery of the uterus and ovaries (Lean et al., 1991; Tveit et al., 1992; Moon et al., 2002). The free fatty acid (FFA) was significantly higher in the treatment than the control ($p < 0.05$).

The average somatic cells counts (SCC) showed 232,330 counts/ml in the control and 249,660 counts/ml in the treatment, showing no significant difference between the experimental groups. However, the control showed a large weekly change during the experiment according to the results after the 1st, 2nd and 3rd week, but the treatment showed little weekly variation, showing 273,000, 246,000 and 230,000 counts after the 1st, 2nd and 3rd week

respectively. In addition, the somatic cells counts (SCC) before the test showed a natural decrease in the control by 73,670 counts after the test (SCC before the test - SCC after 3rd test), and a decrease in the treatment by 83,010 counts. This illustrates that the Dandelion added feed is showing a tendency of stable change and decrease in the somatic cell counts compared to the control. However, it would be a unreasonable to assert its effect of the Dandelion added feed with only three weeks of the experiment, so a longer term research is suggested in the future.

In addition, Dandelion has been reported to have antioxidation activity (Kang et al., 2002; Hu and Kitts, 2003), antimicrobial activity (Kim et al., 1998), anti-cancer and tumor activity suppression (Takasaki et al., 1999), HDL-cholesterol increase (Park et al., 2010), liver protection (You et al., 2010) and anti-inflammation effect (Jeon et al., 2008).

Therefore, research of medicinal plant, such as Dandelion is needed to increase the performance of milking cow and produce the eco-friendly dairy products

2. Effects of Dandelion added feed on the blood components

Table 6 shows the effect of Dandelion added feed on blood components.

First of all, ALB that represents the nutritional status of protein did not show a significant difference between the

Table 6. Effects of Dandelion supplementation on blood components in lactating dairy cows.

Items	Control	Treatment
Albumin (ALB, g/dl)	3.8±0.1 ^{ns}	4.1±0.2
Alkaline phosphatase (ALP, u/ℓ)	66.7±19.6 ^{ns}	55.7±16.0
Aspartate aminotransferase (AST, u/ℓ)	57.7±2.5 ^b	68.0±1.0 ^a
Calcium (Ca, g/dl)	10.1±0.3 ^{ns}	9.9±0.3
γ-GTP gamma glutamyl transpeptidase (GGT, u/ℓ)	26.3±3.2 ^{ns}	34.3±5.1
Total protein (TP, g/dl)	9.1±1.0 ^{ns}	8.4±0.6
Globulin (GLOB, g/dl)	5.3±1.1 ^{ns}	4.3±0.7
Blood Urea Nitrogen (BUN, mg/dl)	14.0±1.7 ^{ns}	17.0±1.0
Creatine Kinase (CK, u/ℓ)	154.3±28.1 ^{ns}	205.0±19.1
Phosphate (P, mg/dl)	6.6±0.6 ^{ns}	6.0±0.5
Magnesium (Mg, mg/dl)	2.4±0.1 ^{ns}	2.6±0.2

^{a, b} Means in the same row with different letters were significantly different ($p < 0.05$).

ns : not significant.

control (3.8 g/dl) and the treatment (4.1 g/dl). Considering that the normal range of ALB is normally in the range of 3.0 ~ 3.6 g/dl, it can be seen that both the control and the treatment are slightly higher. The blood compositions were refer to data provided by Calxis company (Calxis, 2006). Albumin is generally reduced as the protein synthesis increases and decreases by the stress or by low-nutrient feeding. ALP also did not show a significant difference between the control (66.7 u/ℓ) and the treatment (55.7 u/ℓ). It was reported that the increase in ALP caused acute or chronic liver disease and a symptom of obstruction of the bile duct, which is however difficult to use as a sensitive indicator for large animals because ALP range is too wide as 0 ~ 489 u/ℓ (Lee, 2008). AST showed significantly higher in the treatment (68.0 u/ℓ) compared to the control (57.7 u/ℓ) ($p > 0.05$). AST is distributed mainly in the muscles and liver, so the damaged liver can be predicted if the AST levels are high (Lumeij, 1997; Diaz et al., 1999). The treatment can be said to have liver protection ability according to the results before (78.3 u/ℓ) and after (68.0 u/ℓ) the experiment.

This is thought to be able to help prevent and improve

liver damage that occurs due to nutritional and metabolic disorders caused by the excessive concentrate feed and the high yield of the cows. Ca, which indicates the calcium content in the blood, was not significantly different between control (10.1 g/dl) and treatment (9.9 g/dl). The normal range of Ca concentration is 9.7~12.4 mg/dl, which indicates that both the control and treatment have the normal concentrations. Increasing concentrations of Ca reportedly is susceptible to chronic kidney disease, and astasia under 6 mg/dl (Lee, 2008). GGT, a determining factor for liver function, did not show a significant difference between the control (26.3 u/ℓ) and treatment (34.3 u/ℓ), but higher than normal level (6~17 u/ℓ) both in the control and treatment. The high level is believed to be caused by the excessive concentrate feed due to the increase of milk yield. TP, representing the total amount of the protein in blood, did not show significant difference between the control (9.1 g/dl) and treatment (8.4 g/dl); neither did GLOB between the control (5.3 g/dl) and treatment (4.3 g/dl). BUN, used as an index of renal function, did not show significant difference between the control (14.0 mg/dl) and treatment (17.0 mg/dl). It has been reported that the pregnancy rate is reduced if the BUN exceeds 20 mg/dl (Ferguson et. al., 1993). As such, BUN has been used as a useful indicator to determine the protein metabolism and cattle breeding conditions (Roseler et al., 1993). CK, used as an indicator of muscle and brain disease diagnosis, showed no significant difference between the control (154.3 u/ℓ) and treatment (205.0 u/ℓ). The content of P did not show significant difference between control (6.6 mg/dl) and treatment (6.0 mg/dl). The control is beyond the normal range, but the treatment was within the normal range. Mg content also did not show significant differences between control (2.4 mg/dl) and treatment (2.6 mg/dl).

3. Effects of Dandelion added feed on the blood corpuscle components

Table 7 shows the effect of Dandelion added feed on the blood corpuscle components. WBC did not show significance between control ($13.0 \times 10^9/\ell$) and treatment ($8.5 \times 10^9/\ell$). However, considering that the normal range of WBC is $4.00 \sim 12.00 \times 10^9/\ell$, the control showed above the normal

Table 7. Effects of Dandelion supplementation on blood corpuscle compositions in lactating dairy cows

Items	Control	Treatment
White blood cell (WBC, $10^9/\ell$)	13.0±3.3 ^{ns}	8.5±1.5
Lymphocyte (LYM, $10^9/\ell$)	9.9±2.9 ^{ns}	4.2±1.0
Monocyte (MON, $10^9/\ell$)	0.1±0.0 ^{ns}	0.3±0.3
Granulocyte (GRA, $10^9/\ell$)	3.1±0.3 ^{ns}	3.9±2.1
Red blood cell (RBC, $10^{12}/\ell$)	5.9±1.2 ^{ns}	6.5±0.4
Hemoglobin (HGB, g/ ℓ)	107.0±4.2 ^{ns}	126.0±22.6
Hematocrit (HCT, %)	21.6±0.6 ^{ns}	25.4±2.7
Mean corpuscular volume (MCV, fl)	37.0±7.1 ^{ns}	39.0±1.4
Mean corpuscular hemoglobin (MCH, pg)	18.5±3.3 ^{ns}	19.4±2.2
Mean corpuscular hemoglobin concentration (MCHC, g/ ℓ)	496.5±3.5 ^{ns}	496.0±38.2
Red cell distribution width (RDW, %)	25.1±2.4 ^{ns}	26.7±3.0
Platelet count (PLT, $10^9/\ell$)	318.0±5.7 ^{ns}	230.0±49.5
Platelet crit (PCT, %)	0.2±0.0 ^{ns}	0.2±0.0
Mean platelet volume (MPV, fl)	6.3±0.4 ^{ns}	6.2±0.3
Platelet distribution width (PDW, %)	33.5±1.1 ^{ns}	33.6±0.9

ns : not significant.

range, while the treatment maintained the normal range. The blood corpuscle compositions were refer to data provided by Calxis company (Calxis, 2006).

LYM did not show significance between control ($9.9 \times 10^9/\ell$) and treatment ($4.2 \times 10^9/\ell$). Considering that the normal range of LYM is $2.5 \sim 7.5 \times 10^9/\ell$, the control showed higher than normal range, while the treatment maintained the normal range. MON did not show significance between control ($0.1 \times 10^9/\ell$) and treatment ($0.3 \times 10^9/\ell$). Both the control and treatment belonged in the normal range, $0 \sim 0.84 \times 10^9/\ell$. GRA also did not show significance between control ($3.1 \times 10^9/\ell$) and treatment ($3.9 \times 10^9/\ell$), and both the control and treatment belonged in the normal range of $0.6 \sim 6.7 \times 10^9/\ell$. RBC did not show the significance between control ($5.9 \times 10^{12}/\ell$) and treatment ($6.5 \times 10^{12}/\ell$). Both control and treatment kept within a normal range, which is $5 \sim 10 \times 10^{12}/\ell$. HGB levels had no significance between the control (107.0 g/ ℓ) and treatment (126.0 g/ ℓ), both of which kept a normal range (80~150 g/ ℓ). HCT also did not show the significance between control (21.6%) and treatment

(25.4%). However, the control was lower than the normal range. MCV had no significance between the control (37.0 fl) and treatment (39.0 fl), both of which showed lower than the normal range, 40~60 fl. There was no significance in MCH between the control (18.5 pg) and treatment (19.4 pg). Both the control and treatment showed higher than normal range, 11~17 pg. MCHC did not show significance between control (496.5 g/ ℓ) and treatment (496.0 g/ ℓ). However, both the control and treatment showed higher than normal range, 300~360 g/ ℓ . RDW did not show significance between control (25.1%) and treatment (26.7%). PLT also did not show significant between the control ($318.0 \times 10^9/\ell$) and treatment ($230 \times 10^9/\ell$), both of which showed a normal range of $100 \sim 800 \times 10^9/\ell$. PCT did not indicate a significant difference between control and treatment, both of which were 0.2%. MPV had no significance between the control (6.3 fl) and treatment (6.2 fl); neither did the PDW between the control (33.5%) and the treatment (33.6%). Park et al. (2010) reported that extracts of Dandelion had functionality to improve blood composition. Domestic studies are rare on the blood corpuscle components using medicinal plants, but blood corpuscle components may be used as a basis for showing whether the environmental and management conditions of feeding cows are good or adverse (Koubkova et al.; 2002, Kumar and Pachaura; 2000, Nimitsuntiwong et al.; 2000). They can also be used as an indicator of stress and welfare of livestock (Ji et al., 2011). However, it is difficult to review the effects of the Dandelion on the blood corpuscle component because there are no reports of previous researchers. More systematic future research on this is considered to be necessary.

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