The effects of a medical plant mix and probiotic on performance and health status of suckling Holstein calves

Sayyad Seifzadeh, Farzad Mirzaei Aghjehgheshlagh, Hossein Abdibenemar, Jamal Seifdavati and Bahman Navidshad

Department of Animal Science, Faculty of Agriculture and Natural Resources, University of Mohaghegh Ardabili, Ardabil, Iran

ABSTRACT
This study was carried out to evaluate the effects of a medical plant mixture and probiotic on performance, blood parameters, digestibility of some nutrients, and health status of suckling Holstein calves. Thirty newborn calves (1–10 days) with 42 ± 8 kg of average birth weight were used in a factorial arrangement (3 × 2) with 6 treatments and 5 replicate. The treatments were: (1) control diet, (2) control diet +2g probiotic per day, (3) control diet +1.5% medical plant, (4) control diet +1.5% medical plant +2g probiotic per day, (5) control diet +3% medical plant and (6) control diet +3% medical plant +2g probiotic per day. During first month, experimental factors have no effect on starter and hay intake, whereas total DMI was affected by herbal (H) effect in second month (p < .01). Calves fed on H1.5 diet had the highest starter and total DMI and calves fed on PH3 diet had the lowest value. Daily weight gain (DWG) was affected significantly by H (p < .01) whereas no effect from P was observed. Treatments had no significant effect on blood glucose, cholesterol and albumin content, whereas addition of H1.5 in starter feed increased beta-hydroxy butyric acid (BHBA) concentration in comparison to other groups (p < .05). In conclusion and based on better growth performance, it is recommended to feed H1.5 to milk suckling calves and feeding herbal additives with probiotic is not recommended.

Introduction
Rearing calves is among the most important and sensitive management plans in cattle farms as calves are considered major sources of profits for farms. Hence, it is extremely important to apply proper approaches to nutrition in order to improve growth and health of the calves (Anderson & Nagaraja 1987). Herbs contain a wide range of photochemical compounds with anti-microbial effects which may have useful or harmful impact on animals depending on the type and concentration of such compounds (Cowan 1999; Wink 2004; Acavomic & Brooker 2005). The limitations imposed on application of growth promoting antibiotics into animal and poultry feeds have led to numerous studies that attempted to find appropriate alternatives for antibiotics (Cross et al. 2007). Studies on a number of secondary metabolites such as tannins, saponins and herbal extracts have shown their favourable impacts on fermentation in the rumen, digestibility of nutrients, and production performance of ewes and cattle (Lila et al. 2003; Busquet et al. 2006; Beauchemin et al. 2007; Benchaar et al. 2006, 2008). Qiao et al. (2013) added Chinese herbs to diets fed to Holstein cows to show improvements in antioxidant indices and immunity system; adding Chinese herbs resulted in increased concentration of IgG and interferon gamma compared to the control group. In a number of in vitro studies, Benchaar et al. (2006) showed that digestibility of nutrients (N, ADF, NDF, DM, and OM) was not affected by different levels of herbs. Qiao et al. (2013) demonstrated that adding Chinese herb resulted in improved digestibility of nutrients and performance of Holstein heifers. Herbal extracts and flavours, alone or in combination, may improve health and performance (Janssen et al. 1987; Horton et al. 1991; Bakhiet & Adam 1995; Skrabka-Blotnicka et al. 1997; Gill 2000).

Another feed additive that was interested as an alternative for antibiotics is probiotics (Riddell et al. 2010; Hume 2011). In the neonate, the microbial population of the gastrointestinal tract (GIT) is in transition and extremely sensitive (Nousiainen et al. 2004) and
beneficial effects of feeding probiotics to neonatal livestock to maintain normal intestinal microorganisms rather than as a production stimulant have been reported earlier (Fuller 1989). As we know, there are no study focussing on combined effects of medical plants and probiotics in suckling calves. Then, the objectives of this study were to evaluate effects of a commercial medical plant mix and probiotic on performance, blood parameters, and nutrient digestibility and health status of Holstein calves.

**Materials and methods**

**Animals and diets**

Thirty newborn Holstein male calves (average birth weight = 42 ± 8 kg; age = 1–10 days) were selected from Moghan Agro-Industrial and Animal Husbandry herd to determine the effects of a medical plant mix and probiotic on performance, blood parameters, nutrient digestibility and health status of them. Experimental treatments were: (1) control diet without any feed additive, (2) control diet +2 g probiotic per head per day, (3) control diet +1.5% medical plant mix, (4) control diet +1.5% medical plant +2g probiotic, (5) control diet +3% medical plant mix and (6) control diet +3% medical plant +2 g probiotic per head per day. Initial average age of calves in each group was 7, 9, 8, 10, 6 and 7, respectively and initial body weights of them are shown in Table 3. Calves group was 7, 9, 8, 10, 6 and 7, respectively and initial body weight average among the group. Calves were fed colostrum by a nipple pail until 3 days of age and weight average among the group. Calves were housed in individual pens. The medical plant mixture was mixed with the starter feed and provided to the animals. The ingredients and chemical composition of starter feed, and chemical composition of alfalfa hay and the medical plant mix are shown in Table 1.

Body weight change was measured every 2 weeks by weighing calves in the morning just before feeding. Individual starter and hay intake was measured every 3 days by difference between feed offered and feed refused.

Blood samples were collected from the jugular vein on the end of the trial (4 h after the morning feeding) by heparinised venoject tubes, centrifuged at 3500 rpm for 15 min at 4°C, and collected plasma was immediately transported to the laboratory and frozen at −20°C until analysis. Plasma concentrations of glucose, beta-hydroxy butyric acid (BHBA), triglyceride, cholesterol, albumin and total protein were measured by using the commercial kits (Pars Azmoon co, Tehran, Iran).

A faecal sample collection method was done for measuring apparent nutrient digestibility. During the

---

**Table 1.** Ingredient of starter feed and chemical composition of starter, alfalfa hay and herbal additive.

| Ingredients of the starter feed | Nutrients | Chemical analysis |
|---------------------------------|-----------|------------------|
|                                 |           | Starter | Alfalfa | Herbal additive |
| Barley                          | % (as fed) | Dry matter, % | 90.48 | 89 | 96.38 |
| Soybean Meal                    | 22.1      | Energy, kcal/kg | – | – | 3781 |
| Molasses                        | 28.8      | Crude protein, % | 22.10 | 15 | 10.33 |
| Salt                            | 5.6       | EE, % | 2.28 | 1.9 | – |
| Shell                           | 2.0       | ADF, % | 11.00 | 50 | – |
| Min premix                      | 1.0       | NDF, % | 24.00 | 37 | – |
| Vitamin premix                  | 0.04      | Calcium, % | 0.62 | 1.5 | 1.04 |
|                                 | –         | Phosphorus, % | 0.42 | 0.21 | 0.47 |

Vitamin Premix provided per kg of diet: vit A, 200,000 IU; vit D3, 300,000 IU; vit E, 10,000 IU; vit K, 2 mg; anti-oxidant 1000 mg/kg. Mineral premix provided per kg of diet: Cu, 3300 mg/kg; Fe, 100 mg; Zn, 16500 mg/kg; Mn, 9000 mg; I, 120 mg/kg; Co, 90 mg/kg; Se, 90 mg/kg.

EE: ether extracts; ADF: acid detergent fibre; NDF: neutral detergent fibre.
faecal collection, calves were fed the experimental diets and faecal samples were collected for 5 consecutive days and 2 samples per day during last 5 days of the trial. Faecal samples were dried at 65°C for 48 h and pooled by calf and kept until analysis for chemical composition. For chemical analysis, feed and faecal samples were dried, ground with a 1-mm sieve and analysed for dry matter (DM), organic matter (OM), ether extract (EE), crude Ash (AOAC 1990), neutral detergent fibre (NDF) and acid detergent fibre (ADF) (Van Soest et al. 1991). For determining the nutrients digestibility, acid insoluble ash (AIA) was used as an internal marker based on the method of Van Keulen and Young (1977).

Individual animal health scores were assigned daily to the calves by a single veterinarian. Scores were assigned to the calves from birth to d70. Health scores were assigned using a calf health-scoring system developed by the School of Veterinary Medicine, University of Wisconsin, Madison. Calves were scored on 4 different aspects of health including nasal, eye, ear, faecal, and cough scores.

**Statistical analysis**

Data were analysed by GLM procedure of SAS (SAS Institute 2004) with factorial arrangement of the treatments using following model:

$$Y_{ijk} = \mu + \text{H}_i + \text{P}_j + \text{HP}_{ij} + e_{ijk}$$

where: $\mu$ = overall average, $H$ = effect of medical plant additive ($i = 1, 2$), $P$ = effect of Probiotic ($j = 1, 2$), $HP$ = interaction effect of medical plant additive and probiotic, $e$ = error effect.

The level of statistical significance was presented at $p < .05$.

**Results and discussion**

**Intake and growth performance**

The effect of experimental treatments on calves feed intake is shown in Table 2. During the first month, experimental factors have no effect on starter and hay intake, whereas total DMI was affected by herbal (H) effect in second month ($p < .05$). Calves fed on H1.5 diet had the highest starter and total DMI and calves fed on PH3 diet had the lowest value. The lower DMI in diets with higher levels of herbal additive may be attributed to the negative effects of high amounts of essential oils on gastrointestinal microflora and animal tissues (Lambert et al. 2001). Calves had lower herbal additive intake in first month because lower starter intake in comparison to second month and therefore the effects of herbal additive on DMI was observed in second month. In addition, overall starter intake was affected by H ($p < .01$) and P had no effect on starter, hay or total intake. Feeding of 250 mg per day of oregano EO in sheep (Wang et al. 2009), 2 g of juniper berry EO (containing 35% $\alpha$-pinene) in cows (Yang et al. 2007) and 0.75 or 2 g of EO mixture in dairy cattle (Benchaar et al. 2006, 2008) did not influence feed intake. Similar to our results, Ababakri et al. (2012) reported that peppermint oil addition in starter feed increased alfalfa intake in suckling Holstein calves. The reduction of feed intake registered by groups H3 and PH3 could be due to natural prevention negative effects of high amount of essential oils on gastrointestinal microflora and animal tissues (Lambert et al. 2001).

Generally, improvement in animal performance due to the addition of herbal additives could be attributed to presence of the different chemical compounds in these plants that can affect the digestive tract, feed intake and growth performance.
Masucci et al. (2011). In present study, calves in different bacteria including detrimental or beneficial finding may be due to the negative effects of EO on when probiotic coincided with herbal additive. This however, we did not observe these positive effects mean DWG in comparison to other calves, significantly. P group (fed only probiotic without herbal supplement) had similar DWG with H1.5 group and higher treatment differences compared with control; \( p < 0.01 \) whereas no effect from P was observed. In addition, there was significant effect (\( p < 0.01 \)) of H×P interaction on DWG (Table 3). Calves fed P and H1.5 diets presented higher body weight gain and the highest daily weight gain were recorded in calves fed H1.5 group with 12.63% higher daily gain compared to the control. Probiotic additive in the diet of young calves has been shown to improve performance characteristics including body weight gain and feed conversion indices as well as average daily gain in the first two weeks of life (Timmerman et al. 2005). The beneficial effects of probiotics on performance and health were reported by earlier works (Di Francia et al. 2007; Masucci et al. 2011). In present study, calves in P group (fed only probiotic without herbal supplement) had similar DWG with H1.5 group and higher mean DWG in comparison to other calves, significantly. However, we did not observe these positive effects when probiotic coincided with herbal additive. This finding may be due to the negative effects of EO on different bacteria including detrimental or beneficial species (Calsamiglia et al. 2007). The lower DWG that was registered with the same significance in treatment 5 and 6 may be due to the adverse effects of high EO level on microflora and other tissues (Lambert et al., 2001). Riddell et al. (2010) reported that usage of probiotic in calf starter feeds had no significant effect on body weight gain in calves. Soltan (2009) reported that essential oils (mint and Eucalyptus) mixture supplementation at different levels in milk replacer for calves had no effect on daily body weight gain when compared to the control. Carlotto et al. (2006) observed that essential oil had no significant effect on average daily gain of calves during different weeks of experiment. Fathi et al. (2009) reported that addition of vanilla in calf starter feed, increased daily weight gain in Holstein calves. Generally, body weight gain depends on feed intake and nutrient digestibility and animal health (Ababakri et al. 2012). Therefore higher body weight gains in calves fed 1.5% medical plants may be due to the higher starter intake and healthier calves in this group.

Feed conversion ratio (FCR) was not statistically different (Table 3) between treatment groups. Similarly, Yang et al. (2007) observed no significant effect on FCR by addition of 200 mg/kg of cinnamaldehyde and or carvacrolin to calves diet. Also, Bampidis et al. (2005) reported a non-significant effect on growth and FCR by addition of leaves of oregano in lambs when compared with control. These findings are consistent with Hosseinabadi et al. (2013) who confirmed that there is a non-significant effect on FCR by addition of probiotic in during pre-weaning period in calves. The present results are supported by those obtained by Riddell et al. (2010) who reported a non-significant effect on FCR in calves fed bacterial probiotic treated diet. These results were disagree with the findings of Mohamadi and Dabiri (2012), who added probiotic to calves diets and observed significant improvement on FCR.

### Apparent nutrients digestibility

Effects of experiment factors on apparent nutrients digestibility are shown in Table 4. Herbal additive had significant effect on ADF and NDF digestibility \( (p < 0.05) \), whereas no effect of probiotic addition was observed. Hosseinabadi et al. (2013) observed that addition of probiotic had no effect on DM, OM and ADF digestibility. Di Francia et al. (2007) observed that fungal additive improved fibre digestibility. Nevertheless, Masucci et al. (2011) observed no effect

---

### Table 3. Effects of herbal additive (H) and probiotics (P) supplementation on calves performance.

| Treatments | CTR | P | H1.5 | PH1.5 | H3 | PH3 | SEM | H | P | H×P | p value |
|------------|-----|---|------|-------|----|-----|-----|---|---|---|--------|
| Probiotic level | 0 | 2 | 0 | 2 | 0 | 2 |  |  |  |  |  |  |
| Herbal addition level | 0 | 0 | 1.5 | 1.5 | 3 | 3 |  |  |  |  |  |  |
| Initial BW, kg | 43.6 | 42.0 | 42.8 | 40.8 | 41.9 | 42 | 2.2 | ns | ns | ns |  |
| Final BW, kg | 103.6 | 106.3 | 111.4 | 100.2 | 103.0 | 100.5 | 2.4 | ns | ns | * |  |
| DWG, kg/d | 0.8 | 0.9 | 1.0 | 0.8 | 0.7 | 0.8 | 0.03 | ns | ns | * |  |
| FCR | 1.4 | 1.5 | 1.4 | 1.4 | 1.5 | 1.5 | 0.07 | ns | ns | ns |  |

H: herbal; P: probiotic; BW: body weight; DWG: daily weight gain; FCR: feed conversion ratio. Treatment differences compared with control; \( p < 0.01 \), \( p < 0.05 \). *Means in a same row with different superscripts are significantly different \( (p < 0.05) \).
of a bacterial probiotic on nutrient digestibility. The lack of probiotic effect on nutrient digestibility may be attributed to the fact that the digestibility trial was performed at the end of experiment when the calves fed enough amounts of starter and had a developed rumen. El-Bordeny et al. (2005) reported that adding Eucalyptus globulus leaves to buffalo calves rations improved nutrients digestibility. Benchaar et al. (2006) reported that addition of essential oil mix had no effect on OM digestibility in dairy cows diet. As well as, Anassori et al. (2012) indicated that supplementation experimental feeds with some plant EO decreased DM, crude protein and ADF digestibility. Hamidi et al. (2012) did not observe any significant effect on nutrient digestibility by thyme addition to the goat’s diets. It has been shown that the plant EO and some secondary metabolites including unsaturated fatty acids influenced OM ruminal digestion and fermentation, because they could pair with OM and change site of nutrient digestion from rumen to the intestine (Hamidi et al. 2012).

Blood parameters
Effects of experimental treatments on blood metabolites are shown in Table 5. Blood parameters were not affected by H and except for total protein concentration; other blood metabolites were not influenced by feeding herbal additive such as. Soltan (2009) confirmed that there is no detrimental effect on serum glucose concentration by addition of eucalyptus oil, mint and menthol crystal in calves’ diet. In addition, Hosoda et al. (2006) found that serum cholesterol concentration was not affected by addition of mint and spikenard. These findings are in disagreement with results of Ardekani et al. (2010) who reported that using of cumin caused decreased glucose, cholesterol and triglyceride in mice’s serum. Similarly, Moslemipur et al. (2014) reported that a non-significant effect on serum total protein concentration by of probiotic additive in calves milk and colostrum. Riddell et al. (2010) observed no significant effect on total protein concentration in probiotic added diets. Blood BHBA concentration affected significantly by H and P interaction effect (p < .05), and the highest value was recorded for treatment 3 (calves fed 1.5% herbal additive supplemented starter feed). BHBA concentration is a good indicator of ruminal fermentation and VFA production and it is index of rumen development (Chaves et al.2008; Wang et al. 2009). Greenwood et al. (1997) established that BHBA amount enhances with growing of age, due to increase of carbohydrate amount in the rumen. Also, they explained that enhancing of forage level resulted in increasing plasma BHBA concentration. Increased ruminal VFAs production by cinnamaldehye (Chaves et al. 2008) and spearmint in (Wang et al. 2009) supplementation has been reported earlier.

Health status of dairy calves
Effect of experimental factors on some health scores of calves are presented in Table 6. Nasal discharge was

### Table 4. Effects of herbal additive (H) and probiotic (P) supplementation on calves apparent nutrients digestibility.

| Treatments | CTR | P | H1.5 | PH1.5 | H3 | PH3 |
|------------|-----|---|------|-------|----|-----|
| Probiotic level | 0 | 2 | 0 | 2 | 0 | 2 |
| Herbal additive level | 0 | 0 | 1.5 | 1.5 | 3 | 3 |
| p value | | | | | | |
| DM, % | 82.2 | 82.6 | 84.6 | 86.3 | 81.8 | 81.6 |
| OM, % | 84.4 | 83.8 | 86.2 | 85.6 | 84.8 | 84.2 |
| NDF, % | 57.2bc | 56.0c | 60.6a | 58.0bc | 55.2c | 54.6c |
| ADF, % | 56.4ab | 55.2c | 58.0c | 57.6bc | 56.0c | 55.6c |
| SEM | | | | | | |
| H | P | H*P |
| ns | ns | ns | ns | ns | ns |
| ns | ns | ns | ns | ns | ns |
| ns | ns | ns | ns | ns | ns |
| H: herbal; P: probiotic; DM: dry matter; OM: organic matter; CF: crude fat; EE: ether extracts; ADF: acid detergent fibre; NDF: neutral detergent fibre. Treatment differences compared with control; *p < .01, **p < .05. 
| H1: Means in a same row with different superscripts are significantly different (p < .05).

### Table 5. Effects of herbal additive (H) and probiotics (P) supplementation on calves blood parameters.

| Treatments | CTR | P | P1.5 | PH1.5 | H3 | PH3 |
|------------|-----|---|------|-------|----|-----|
| Probiotic level | 0 | 2 | 0 | 2 | 0 | 2 |
| Herbal additive level | 0 | 0 | 1.5 | 1.5 | 3 | 3 |
| p value | | | | | | |
| Glucose, mg/dL | 77.51 | 62.38 | 80.45 | 83.96 | 74.35 | 79.88 |
| Cholesterol, mg/dL | 74.03 | 62.99 | 77.64 | 79.83 | 68.61 | 68.03 |
| Triglyceride, mg/dL | 16.57 | 12.85 | 14.47 | 15.49 | 14.49 | 12.96 |
| BHBA, µmol/L | 0.17b | 0.25b | 0.41a | 0.17b | 0.20b | 0.26b |
| Albumin, g/dL | 3.19 | 3.58 | 3.56 | 3.43 | 3.16 | 3.20 |
| Total Protein, g/dL | 7.56ab | 8.62ab | 7.62b | 7.80b | 8.78bc | 9.54a |
| Treatment differences compared with control; *p < .01, **p < .05. 
| H1: Means in a same row with different superscripts are significantly different (p < .05).
not affected by P, H or P × H whereas probiotic supplementation affected significantly eye score (p < .01). Calves fed on treatment 2 had the lowest score and the highest was recorded for control group. In addition, calves fed on experimented treatments generally had lower health scores compared to the control. Hosseinabadi et al. (2013) observed a significant effect on calves health by probiotic addition during preweaning period. Similarly, Aldana et al. (2009) indicated that probiotic supplementation in milk replacer and starter feed decreased faecal score and improved calves health. In contrast, Laborde (2008), reported that addition of yeast culture increased faecal score. It was shown that botanical compound being active against damaging compounds, such as mycotoxin (Leung & Foster 1996). Therefore, Phytogenic compounds may aid in improving digestive processes, particularly during the early stages of life, resulting in higher performance finally (Williams & Losa 2001). The beneficial effect which obtained in experimental treatments may be attributed to the antimicrobial effect of EOM (Cowan 1999), that can result in increased digestive efficiency. Also, botanical components may influence the animal health by enhanced endogenous enzyme secretion, improved gut environment and microflora balance and increased liver function to better utilisation of fats and proteins (Abe et al. 1995; Donovan et al. 2002; Khuntia & Chaudhary 2002; Timmerman et al. 2005).

**Conclusions**

Based on obtained results, herbal additive significantly improved calves’ daily gain at lower inclusion level and in higher level, it may have adverse effect on calves intake and performance. In addition, the positive effects of herbal additive on digestibility of some nutrients inducing ADF and NDF were observed. Calves in group with H1.5 additive had significantly higher blood BHBA concentration. Probiotics supplementation affected significantly some health scores including eye and ear score. In conclusion and based on better growth performance, it is recommended to feed H1.5 to milk suckling calves and feeding herbal additives with probiotic is not recommended.

**Disclosure statement**

The authors report no conflicts of interest. The authors alone are responsible for the content and writing of this article.

**References**

| Table 6. Effects of herbal additive (H) and probiotic (P) supplementation health status of calves. |
|---------------------------------------------------------------|
| **Treatments** | **CTR** | **P** | **H1.5** | **PH1.5** | **H3** | **PH3** | **p value** |
| Probiotic level | 0 | 2 | 0 | 2 | 0 | 2 | | |
| Herbal additive level | 0 | 1.5 | 1.5 | 1.5 | 3 | 3 | SEM | H | P | H×P |
| Nasal discharge score | 0.28 | 0.17 | 0.14 | 0.14 | 0.08 | 0.14 | 0.06 | ns | ns | ns |
| Eye score | 0.71* | 0.28b | 0.48b | 0.29b | 0.37b | 0.43b | 0.09 | ns | ns | ns |
| Ear score | 0.71* | 0.29b | 0.46b | 0.46b | 0.28b | 0.46b | 0.08 | ns | ns | ns |
| Cough score | 0.28 | 0.11 | 0.06 | 0.14 | 0.08 | 0.06 | 0.06 | ns | ns | ns |
| Faecal score | 1.13 | 0.62 | 0.81 | 0.61 | 0.74 | 0.81 | 0.13 | ns | ns | ns |

Treatment differences compared with control; *p < .01, **p < .05.

**AOAC.** 1990. Official methods of analysis. Arlington (VA): AOAC.

**Ababakri R, Riasi A, fathi MH, Naeimipur H, Khorshidi D.** 2012. Effect of peppermint oil added to the initial concentration on ruminal fermentation, weaning age and performance holstein dairy calves. J Appl Anim Sci. 22:141–154.

**Abe F, Ishibashi N, Shimamura S.** 1995. Effect of administration of bifid bacteria and lactic acid bacteria to newborn calves and piglet’s. J Dairy Sci. 78:283–2846.

**Acavonmic T, Brooker JD.** 2005. Biochemistry of plant secondary metabolites and their effects in animals. Proc Nutr Soc. 64:403–412.

**Aldana C, Cabra F, Carlos A, Carvajal F, Rodriguez F.** 2009. Effect of probiotic compound in rumen development, diarrhoea incidence and weight gain in young Holstein calves. World Acad Sci Eng Tech. 57:341–343.

**Anassori E, Dalir-Naghadeh B, Pirmohammadi R, Taghizadeh A, Asri-Rezaei S, Farahmand-Azar S, Besharati M, Tahmoozi M.** 2012. In vitro assessment of the digestibility of forage based sheep diet, supplemented with raw garlic, garlic oil and monensin. Vet Res Forum. 3:5–11.

**Anderson K, Nagaraja J.** 1987. Ruminal metabolic development in calves weaned conventionally or early. J Dairy Sci. 70:1000–1005.

**AOAC.** 1990. Official methods of analysis. Arlington (VA): AOAC.

**Ardekani J, Akbarian Z, Nazarian A.** 2010. Effects of Cumin (cuminum cyminum l) oil on serum glucose and lipid levels of rats. J Shahid Sadoughi Univ Med Sci. 19:387–397.

**Bakhiet AO, Adam EI.** 1995. Therapeutic utility, constituents and toxicity of some medicinal plants: a review. Vet Hum Toxicol. 37:255–258.

**Bampidis V, Christodoulou V, Florou-Paneri P, Chritski E, Spais A, Chatzopoulou P.** 2005. Effect of dietary dried oregano leaves supplementation on performance and carcass characteristics of growing lambs. Anim Feed Sci Tech. 121:285–295.
Beauchemin KA, McGinn SM, Martinez TF, McAllister TA. 2007. Use of condensed tannin extract from quebracho trees to reduce methane emissions from cattle. J Anim Sci. 85:1990–1996.

Benchaa C, Duynisveld JL, Charmley E. 2006. Effects of monensin and increasing dose levels of a mixture of essential oil compounds on intake, digestion and growth performance of beef cattle. Can J Anim Sci. 86:91–96.

Benchaa C, McAllister TA, Chouinard PY. 2008. Digestion, ruminal fermentation, ciliate protozoal populations, and milk production from dairy cows fed cinnamaldehyde, quebracho condensed tannin, or yucca schidigera saponin extracts. J Dairy Sci. 91:4765–4777.

Busquet M, Calsamiglia S, Ferret A, Kamel C. 2006. Plant extracts affect in vitro rumen microbial fermentation. J Dairy Sci. 89:761–771.

Calsamiglia S, Busquet M, Cardozo PW, Castillejos L, Ferret A. 2007. Invited review: essential oils as modifiers of rumen microbial fermentation. J Dairy Sci. 90:2580–2595.

Carlotto SB, Olive CJ, Viegas J, Stiles DA, Gabbi AM, Brustolin KD, Charao PS, Rossarolla G, Ziech M. 2006. Performance and behaviour of dairy calves fed diets containing milk and citric flavour agents. Cienc Agrotec Lavras. 31:889–895.

Chaudhary L, Sahoo A, Agraval N, Kamra D, Pathak N. 2008. Effect of direct fed microbial on nutrient utilisation, rumen fermentation, immune and growth response in crossbred cattle calves. Indian J Anim Sci. 78:515–521.

Chaves AV, Stanford K, Gibson L, McAllister TA, Benchaa C. 2008. Effects of carvacrol and cinnamaldehyde on intake, rumen fermentation, growth performance, and carcass characteristics of growing lambs. Anim Feed Sci Tech. 145:396–408.

Cowan MM. 1999. Plant products as antimicrobial agents. Clin Microbiol Rev. 12:564–582.

Cross DE, Mcdevitt RM, Hillman K, Acamovic T. 2007. The effects of three herbs as feed supplements on blood metabolites, hormones, antioxidative activity, IgG concentration, and ruminal fermentation in holstein steers. Asian Aust J Anim. 19:35–41.

Hamidi A, primohamadi R, Mansori H, Fajri M. 2012. The effects of adding thymus plant to lactating goats rations on digestibility parameters and milk yield performance. Anim Sci J (Pajouhesh & Sazandegi). 10:29–36.

Horton GM, Fennell MJ, Prasad BM. 1991. Effect of dietary garlic (Allium sativum) on performance, carcass composition and blood chemistry changes in broiler chickens. Can J Anim Sci. 71:939–942.

Hosoda K, Kuramoto K, Eruden B, Nishida T, Shiyo S. 2006. The effects of three herbs as feed supplements on blood metabolites, hormones, antioxidative activity, IgG concentration, and ruminal fermentation in holstein steers. Asian Aust J Anim. 19:35–41.

Hosseinabadi M, Dehghan-Banadaky M, Zali A. 2013. The effect of feeding of bacterial probiotic in milk or starter on growth performance, health, and rumen parameters of suckling calves. Res Anim Product. 4:8–14.

Hume M. 2011. Food safety symposium: potential impact of reduced antibiotic use and the roles of prebiotics, probiotics, and other alternatives in antibiotic-free broiler production. Poultry Sci. 90:2663–2669.

Janssen AM, Scheffer JJC, Baerheim Svendeaen A. 1987. Antimicrobial activity of essential oils: a 1976–1986 literature review. Aspects of the test methods. Planta Med. 53:395–398.

Khuntia A, Chaudhary LC. 2002. Performance of male cross bred calves as influenced by substitution of grain by wheat bran and the addition of lactic acid bacteria to diet. Asian Aust J Anim. 15:188–194.

Laborde J. 2008. Effects of probiotics and yeast culture on rumen development and growth of dairy calves [thesis]. Baton Rouge (LA): Faculty of the Louisiana State University and Agricultural and Mechanical College; p. 54.

Lambert RJ, Skandamis PN, Coote PJ, Nychas GE. 2001. A study of the minimum inhibitory concentration and mode of action of oregano essential oil, thymol and carvacrol. J Appl Microbiol. 91:453–462.

Leung AY, Foster S. 1996. Encyclopaedia of common natural ingredients used in food, drugs and cosmetics. 2nd ed. New York: Wiley; p. 173–175.

Lila ZA, Mohammed N, Kanda S, Kamada T, Itabashi H. 2003. Effect of sarsaponin on ruminal fermentation with particular reference to methane production in vitro. J Dairy Sci. 86:3330–3336.

Masucci F, De Rosa G, Di Francia A, Masucci F, De Rosa G, Grasso F, Napolitano F, Esposito G, De Rosa G. 2011. Performance and immune response of buffalo calves supplemented with probiotic. Livest Sci. 137:24–30.

Mohamadi P, Dabiri M. 2012. Effects of probiotic and prebiotic on average daily gain, fecal shedding of Escherichia coli, and immune system status in newborn female calves. Asian-Aust J Anim Sci. 25:1255–1261.

Moslemipour F, Moslemipour F, Mostafaloo Y. 2014. Effects of using probiotic and synbiotic incolostrum and milk on passive immunoglobulin transfer rate, growth and health parameters of calf. J Rumin. Res. 4:56–62.

Nouseinien J, Javanainen P, Setala J. 2004. Lactic acid bacteria: microbiology and functional concepts. 3rd ed. Helsinki, Finland: Valio Ltd; p. 547–588.

Qiao G, Shao T, Yang X, Zhu X, Li J, Lu Y. 2013. Effects of supplemental Chinese herbs on growth performance, blood antioxidation function and immunity status in...
holstein dairy heifers fed high fibre diet. Ital J Anim Sci. 12:1–20.

Riddell JB, Gallegos A, Harmon D, Mcleod K. 2010. Addition of a Bacillus based probiotic to the diet of pre ruminant calves: influence on growth, health, and blood parameters. Int J Appl Res Vet M. 8:78–85.

SAS Institute. 2004. SAS/STAT User’s Guide. Release. 9.1. Cary (NC): SAS Inst. Inc.

Skrabka-Blotnicka T, Rosin’ski A, Przysie-Zzna E, Woloszyn J, Elminowska-Wenda G. 1997. The effect of dietary formulation supplemented with herbal mixture on goose breast muscle quality. Report 1: The Effect on the Chemical Composition. Archiv für Geflügelkunde. 61:135–138.

Soltan MA. 2009. Effect of essential oils supplementation on growth performance, nutrient digestibility, health condition of Holstein male calves during pre- and post- weaning periods. Pak J Nutr. 8:642–652.

Timmerman HM, Mulder H, Everts DC, van Espen E, van der Wal G, Klassen MG, Rouwers R, Hartemink F, Beynen AC. 2005. Health and growth of veal calves fed milk replacers with or without probiotics. J Dairy Sci. 88:2154–2165.

University of Wisconsin [Internet]. [cited 2015 Dec 22]. Available from: www.vetmed.wisc.edu/dms/fapm/fapm-tools/8calf/calf_health_scoring_chart.pdf.

Van Keulen J, Young BA. 1977. Evaluation of acid-insoluble ash as a natural marker in ruminant digestion studies. J Anim Sci. 44:282–287.

Van Soest PJ, Robertson JB, Lewis BA. 1991. Methods for dietary fiber, neutral detergent fiber, and nonstarch polysaccharides in relation to animal nutrition. J Dairy Sci. 74:3583–3597.

Wang CJ, wang S, Zhou H. 2009. Influences of flavomycin, ropadiar, and saponin on nutrient digestibility, rumen fermentation, and methane emission from sheep. Anim Feed Sci Tech. 148:157–166.

Williams P, Losa R. 2001. The use of essential oils and their compounds in poultry nutrition. World Poultry. 17:14–15.

Wink M. 2004. Evolution of toxins and anti-nutritional factors in plants with special emphasis on Leguminosae. Heidelberg, Germany: CABI Pub; p. 1–25.

Yang W, Benchaarc B, Chaves H, Mcallister T. 2007. Effects of garlic and juniper berry essential oils on ruminal fermentation and on the site and extent of digestion in lactating cows. J Dairy Sci. 90:5671–5681.