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Unnikrishnan MP

Associate Professor, Centre for
Pig Production and Research,
Kerala Veterinary and Animal
Sciences University, Mannuthy,
Kerala, India

R Thirupathy Venkatachalapathy

Professor and Head, Centre for
Pig Production and Research,
Kerala Veterinary and Animal
Sciences University, Mannuthy,
Kerala, India

Effect of dietary supplementation of turmeric extract (*Curcuma longa*) on health status and survival rate of pre-weaned and post-weaned piglets

Unnikrishnan MP and R Thirupathy Venkatachalapathy

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Abstract

In livestock nutrition, natural feed additives are gaining increased attention as alternatives to antibiotic growth promoters to improve animal performance. This study investigated the effects of dietary turmeric extract supplementation to pregnant and farrowed sows as well as to pre-weaned and post-weaned piglets on the growth performance and survivability of piglets. Study revealed that turmeric extract supplementation to pregnant sows @ 500mg/day/sow during last quarter of pregnancy improved their subsequent lactation and postnatal daily body weight gain of piglets. Turmeric extract supplementation to pre-weaned piglets @ 2 50mg/day/piglet enhanced their growth performance. Turmeric extract at the supplemented rate in the present study had no significant influence on survival rate of piglets.

Keywords: Turmeric extract, supplementation, piglets, weight gain, survivability

1. Introduction

Antibiotics have been widely used as growth promoters in livestock to improve animal performance and profitability by improving feed efficiency and animal growth, as well as reducing the incidence of diseases (Cheng *et al.*, 2014) ^[9]. In particular, nursery pigs are supplemented with antibiotics for disease prevention or to reduce morbidity and mortality (Li, 2017) ^[16]. The use of antimicrobials in food-producing animals leads to multidrug resistance in both animals and humans (Tollefson and Karp, 2004) ^[25]. Therefore, several countries have banned or placed restrictions on antibiotic use in animal feed (Bengtsson and Wierup, 2006) ^[6]. Thus, it is necessary to adopt alternative approaches for antibiotic use.

Bengmark (2013) ^[5] reported that intestinal microbiota might be a potential novel strategy to modulate the general immune system and gut health. The gut microbiome plays a major role in immune system development, maintaining nutrient metabolism, performance, disease defense and health status of the host (Sekirov *et al.*, 2010) ^[21]. Recharla *et al.* (2021) ^[20] reported that turmeric supplementation significantly increased body weight gain among piglets by positively altering the gut microbiota and short-chain fatty acid (SCFA) production in the intestine. The beneficial effects of dietary inclusion of turmeric on growth performance and digestibility of pigs have been reported earlier (Alagbe, 2017) ^[1]. Dietary inclusion of dry turmeric powder at one per cent level in pre and post weaning diets is reported to be beneficial for growth performance of LWY piglets (Stevenson *et al.*, 2023) ^[22]. Turmeric plays a vital role in traditional medicinal preparations as an antimicrobial and anti-carcinogenic agent (Panpatil *et al.*, 2013) ^[18]. Turmeric, also known as the golden spice, is derived from *Curcuma longa* Linnaeus rhizomes (Recharla *et al.*, 2021) ^[20]. It contains carbohydrates, fat, protein, minerals, and moisture at approximate per cent of 69.40, 5.10, 6.30, 3.50 and 13.10, respectively (Dono, 2018) ^[10]. Indigestible carbohydrates, such as resistant starch and other carbohydrates are fermented by microbes in the large intestine and produce SCFAs and other products. The bioactive compounds of turmeric consist of volatile and non-volatile phytochemicals that are less toxic and have beneficial effects (Miquel *et al.*, 2002) ^[17].

Corresponding Author:

R Thirupathy Venkatachalapathy

Professor and Head, Centre for
Pig Production and Research,
Kerala Veterinary and Animal
Sciences University, Mannuthy,
Kerala, India

The main bioactive compounds in turmeric are curcuminoids, which constitute 1-6 per cent of the dry weight of turmeric (Zam, 2018) ^[27]. The three major curcuminoids are curcumin (80%), desmethoxycurcumin (18%), and the rest 2 per cent bisdemethoxycurcumin (Gupta *et al.*, 2013) ^[12]. Curcumin, 1, 7-bis (4-hydroxy-3-methoxyphenyl)-1, 6-heptadiene-3, 5-Dione), also known as diferuloylmethane, is a natural bioactive polyphenolic compound. Curcumin accounts for most of the biological and pharmacological effects of *C. longa* including immunomodulating, anti-tumour, anti-inflammatory, anti-oxidant, anti-mutagenic, anti-bacterial, anti-fungal and anti-viral activities. Notably, curcumin is found to be promising as an inhibitor of porcine reproductive and respiratory syndrome (PRRS) virus infection *in vitro* (Du *et al.*, 2017) ^[11].

Many farmers are feeding turmeric extract to young pigs to reduce enteric infections as well as to promote overall health and growth. Hence, this investigation was planned with an objective to assess the effect of feeding turmeric extract on body weight gain and survival rate of pre and post-weaned piglets.

2. Materials and Methods

2.1 Selection of experimental animals and management

Four trials were conducted using Large White Yorkshire (LWY) pigs during March-May, 2024. In each trial, animals were randomly selected from the stock of Centre for Pig Production and Research, Kerala Veterinary and Animal Sciences University, Mannuthy, Kerala, India. Animals were maintained in well-ventilated pens, sows were individually housed in a disinfected farrowing pen, vaccinated against FMD and Classical Swine Fever as per standard vaccination

schedule. Piglets were administered with iron injection on days 3 and 14 of birth. Animals were dewormed with fenbendazole @10mg/kg body weight. Adult animals as well as post weaned piglets were fed with pellet feed containing 18% crude protein and pre-weaned piglets were fed with creep feed mash containing 22% crude protein. All animals were maintained under uniform management conditions. The body weight of piglets was taken in the morning before feeding on weekly basis. The quantity of feed consumed was measured by weighing the feed offered and the residues after one hour of feeding.

2.2 Preparation of premix of turmeric components (TOC) for animal consumption

Turmeric Extract Complex, supplied by Arjuna Natural Pvt. Ltd., was used in the study. The matured rhizome was collected and dried and ground with particle size less than 20 mesh and moisture content less than 5 per cent. The premix was analysed for curcumin content, colour, flavour, odour, moisture, and microbial quality. Total curcuminoid content was 4 per cent (HPLC). As per AOAC (2016) ^[3] and BAM analysis, the microbial assay showed: Total Plate Count < 10,000 cfu/g, yeast and mould < 1,000 cfu/g, absence of *Coliforms* and *E. coli* (per 10 g), and absence of *Salmonella* (per 25 g). On visual examination, the colour was reddish brown. Organoleptic test revealed characteristic flavour and odour of turmeric.

2.3 Experimental diets

The composition of feed given to different category of pigs is displayed in the Table 1.

Table 1: Composition of feed given to sows, post-weaned and pre-weaned piglets

Ingredients quantity	Creep feed for Pre-weaned piglets	Grower/adult feed for post-weaned piglets & adults
Maize/corn (%)	37	35
Soya (%)	23	15
Rice polish (%)	8	19
Wheat bran (%)	20	23
Dried fish (%)	10	6
Mineral mixture (%)	1.5	1.5
Salt (%)	0.5	0.5
Vitamins (%)	0.02	0.02
Lysine (%)	0.02	0.02
Methionine (%)	0.02	0.02
Zinc oxide (%)	0.02	0.02

2.4 Experimental Design

2.4.1 Trial I-Assessment of the effect of dietary supplementation of turmeric extract powder during last month of pregnancy on survival rate and growth performance of piglets born

Pregnant Large white Yorkshire sows in second parity were divided into two groups of 10 animals each (T₁ and T₂). Control group (T₁) was fed with basal diet (control) whereas T₂ was fed with basal diet and turmeric extract in powder form (TOC) @ 500 mg/pig/day, for 30 days prior to farrowing. Birth weight of piglets as well as litter size at birth and weaning were recorded in both the groups. Body weight of piglets was recorded at weekly interval, till weaning on day 45, so as to indirectly assess the milk production of sows. Data were compiled and analysed statistically.

2.4.2 Trial II-Assess the effect of dietary supplementation of turmeric extract powder during lactation on survival rate and growth performance of piglets

The LWY sows in second parity were divided into two groups of 10 animals each (T₁ and T₂). Control group (T₁) was fed with basal diet whereas treatment group (T₂) was fed with basal diet and turmeric extract in powder form (TOC) @ 500 mg/pig/day from the day one of farrowing until weaning of piglets on day 45. In both the groups, birth weight of piglets as well as litter size at birth and weaning were recorded. Body weight of piglets was recorded at weekly interval, till weaning on day 45, so as to indirectly assess the milk production of sows. Data were compiled and analysed statistically.

2.4.3 Trial III-Assessment of growth performance and survival rate of pre-weaned piglets supplemented with turmeric extract

Twenty-four LWY/LWY cross piglets aged 15 days were divided into two groups of 12 each as Control (T₁) and Treatment (T₂). Control group (T₁) was fed with basal diet whereas treatment group (T₂) was fed with basal diet and 250 mg of TOC/piglet/day, until weaning at 45 days. Body weight of piglets was recorded at weekly interval, till weaning on day 45. Survival rate of piglets was also recorded until weaning in both the groups. Data collected were compared and statistically analysed.

2.4.4 Trial IV-Assessment of growth performance and survival rate of post-weaned piglets supplemented with turmeric extract

Thirty LWY piglets aged 45 days were divided into two groups of 15 each as Control (T₁) and treatment (T₂). Control group (T₁) was fed with basal diet whereas Treatment (T₂) was fed with basal diet and 250 mg of TOC/piglet/day, for 30 days. Body weight of piglets and survival rate were recorded at weekly interval from weaning till 90 days from birth in both the groups. Data collected were compiled and statistically analysed.



Fig 1: Turmeric extract powder and sow with piglets

2.5 Statistical analysis

Data generated from all the four trials were analysed by t-test, assuming unequal variance using the SPSS software version 24.0 to find out the significant difference between control and treatment groups.

3. Results

The results of the dietary inclusion of TOC in pregnant sows, farrowed sows, pre and post weaned piglets are presented below.

3.1 Trial I-Assessment of the effect of dietary supplementation of turmeric extract powder during last month of pregnancy on survival rate and growth performance of piglets

Mean daily weight gain of piglets in treatment and control groups was 163.40 ± 1.97 and 144.87 ± 2.89 g, respectively. Significantly higher ($p < 0.05$) daily weight gain was noticed in the TOC fed group compared to control, indicating positive influence on milk production of sows. Mean survival per cent at weaning among TOC fed and control groups was 80.71 ± 1.98 and 78.16 ± 1.92 , respectively. No significant difference ($p > 0.05$) was observed between groups. The mean litter size recorded at birth was 9.80 ± 0.85 and 8.20 ± 0.33 in the treatment and control groups, respectively. Though the litter size was higher in the treatment group, difference was not statistically significant ($p > 0.05$). Mean birth weight was 1.30 ± 0.01 and 1.25 ± 0.01 among treatment and control groups, respectively. No significant difference ($p > 0.05$) was noticed in mean birth weight between groups.

Table 1: Comparison of mean ($\pm$ SE) litter size, birth weight, body weight gain and survival rate of piglets born to sows with and without turmeric extract supplementation during pregnancy

Group	Litter size (no.)		Body weight (kg)		Body weight gain at 45 days		Survival rate (%)
	Birth	weaning	Birth	weaning	Total (kg)	Daily (g)	
Control (T ₁)	8.20 ± 0.33	6.40 ± 0.45	1.25 ± 0.01	7.77 ± 0.13	6.52 ± 0.13	144.87 ± 2.89^a	78.16 ± 1.92
TOC Supplemented (T ₂)	9.80 ± 0.85	7.80 ± 0.80	1.30 ± 0.01	8.65 ± 0.09	7.35 ± 0.09	163.40 ± 1.97^b	80.71 ± 1.98

Mean bearing different lowercase letter as superscript within a column differ significantly ($p < 0.05$)

3.2 Trial II-Assessment of the effect of dietary supplementation of turmeric extract powder during lactation on survival rate and growth performance of piglets

Mean daily weight gain among TOC supplemented and control groups was 165.58 ± 4.34 and 148.07 ± 1.52 g, respectively. The difference between groups was statistically

non-significant ($p > 0.05$), indicating that TOC feeding to sows during lactation has no significant influence on milk production and hence on growth rate of piglets too. Survival per cent at weaning among TOC supplemented treatment and control groups was 76.19 ± 1.93 and 75.10 ± 1.83 , respectively. No significant difference was noticed in survival rate between control and TOC supplemented group.

Table 2: Comparison of mean ($\pm$ SE) litter size, birth weight, body weight gain and survival rate of piglets born to sows with and without turmeric extract supplementation during lactation

Group	Litter size (no.)		Body wt. (kg)		Weight gain at 45 days		Survival rate (%)
	Birth	Weaning	Birth	weaning	Total (kg)	Daily (g)	
Control	9.2 ± 0.79	6.9 ± 0.50	1.37 ± 0.03	8.03 ± 0.08	6.66 ± 0.07	148.07 ± 1.52	75.10 ± 1.83
TOC Supplemented	9.70 ± 0.45	7.4 ± 0.58	1.21 ± 0.02	8.66 ± 0.18	7.45 ± 0.20	165.58 ± 4.34	76.19 ± 1.93

3.3 Trial III: Assessment of growth performance and survival rate of pre-weaned piglets supplemented with turmeric extract

Daily weight gain among TOC Supplemented and control groups was 192.00 ± 6.90 and 171.18 ± 9.01 g, respectively.

Weight gain was significantly ($p < 0.05$) higher in TOC supplemented group, compared to the control. No significant difference was noticed in survival rate between control and TOC supplemented groups.

Table 3: Comparison of mean ($\pm$ SE) body weight gain and survival rate of piglets with and without turmeric extract supplementation during pre-weaning period

Group (N=15)	Body weight (kg)		Body weight gain (30 days)		No. survived at weaning	Survival rate (%)
	day 15	weaning	Total (kg)	Daily (g)		
Control	3.40 ± 0.05	8.50 ± 0.27	5.10 ± 0.27	171.18 ± 9.01^a	11	73.33
TOC Supplemented	3.60 ± 0.09	9.30 ± 0.18	5.70 ± 0.21	192.00 ± 6.90^b	10	66.67

Mean bearing different lowercase letter as superscript within a column differ significantly ($p < 0.05$)

3.4 Trial IV: Assessment of growth performance and survival rate of post-weaned piglets supplemented with turmeric extract

The mean daily weight gain among TOC supplemented and control groups was 143.56 ± 16.73 and 124.48 ± 8.33 g,

respectively. Though the daily weight gain was higher in the TOC supplemented group, difference was not statistically significant ($p > 0.05$). No significant difference was noticed in survival rate between control and TOC supplemented group.

Table 4: Comparison of mean ($\pm$ SE) body weight gain and survival rate of piglets with and without turmeric extract supplementation during post weaning period

Group (N=12)	Body weight (kg)		Weight gain (45 days)		Survival rate (%)
	45 days	90 days	Day 90 (kg)	Daily (g)	
Control	8.38 ± 0.09	13.98 ± 0.38	5.60 ± 0.37	124.48 ± 8.33	100
TOC Supplemented	8.94 ± 0.15	15.40 ± 0.82	6.46 ± 0.75	143.56 ± 16.73	100

4. Discussion

Supplementation of turmeric extract @ 500mg/day/sow in the ration of pregnant sow during last 30 days of pregnancy significantly increased the daily body weight gain of piglets compared to non-fed groups, which is an indirect indication of better milk production among turmeric supplemented sows. It is well known that pregnant sows have increased oxidative stress during late gestation and lactation, which has an adverse effect on milk production (Ao *et al.*, 2016) [2]. Curcumin is excellent source of phenolic compounds, ascorbic and carotenoids which have been reported to show good antioxidant activity (Kamal *et al.*, 2014) [15]. Curcumin is a polyphenol, characterised by the inclusion of two aromatic rings, and its phenolic hydrogen are responsible for its ability to react with reactive species and are believed to impart antioxidant activity to the molecule. Curcumin alleviates oxidative stress in pigs by ameliorating mitochondrial dysfunction, endoplasmic reticulum stress and apoptosis, and by activating the Nrf2 signalling pathway (Hong *et al.*, 2024) [13]. The antioxidant activity of curcumin as a free radical scavenger and as inducer of antioxidant signalling pathways in cells, by enhancing the activity of antioxidant enzymes, such as superoxide dismutase (SOD), catalase (CAT), glutathione peroxidase (GSH-Px), and phase II metabolizing enzymes, hemeoxygenase (HO-1) and quinoneoxidoreductase (Tang *et al.*, 2022) [24] might have caused the beneficial result in the present study by enhancing milk production of sows after farrowing and thus causing higher growth rate among suckling piglets. However, no significant difference was observed in the postnatal survival rate of piglets born to TOC supplemented pregnant sows, compared to control. Since postnatal survival is directly influenced by several factors affecting the piglets in the postnatal life, detailed study is required before making a conclusion.

The TOC supplementation @ 500mg/day/sow in the ration of lactating sows did not have any significant influence on daily body weight gain of piglets, compared to non-supplemented

group, probably an indication of lack of immediate direct effect of TOC on milk production of lactating sows. There is an increased systemic oxidative stress during early lactation of sows (Tan *et al.*, 2015) [23]. The quantity of turmeric supplemented in the present study might be insufficient to neutralise the free radicals released during lactation and hence desired result could not be achieved. The TOC supplementation to mother sows had no beneficial effect on the survival rate of piglets at weaning, probably due to the stronger influence of other factors directly affecting the piglets.

Supplementation of TOC @250mg/day/piglets in the piglet ration improved daily weight gain during pre-weaning period, but not during post weaning period. Oxidative stress causes poor growth performance in piglets (Campbell *et al.*, 2013) [7]. Due to their underdeveloped antioxidant systems, neonatal piglets are unable to efficiently scavenge excessive free radicals, resulting in oxidative stress (Jain, 2016) [14]. The TOC supplementation might have boosted the free radical scavenging capacity of pre-weaned piglets, helping to achieve better growth rate. Curcumin significantly reduced oxidative stress-induced intestinal damage and mitochondrial dysfunction in piglets by promoting Parkin-dependent mitophagy (Cao *et al.*, 2020) [8]. Good percentage of protein in turmeric (Alagbe, 2017) [1] also contributes to achieve better growth rate in turmeric-fed piglets. The beneficial effects of turmeric on growth performance might also be due to the enhanced secretion of amylase, trypsin, chymotrypsin, and lipase enzymes (Balasubramanian *et al.*, 2018) [4]. Recharla *et al.* (2021) [20] reported better nutrient absorption in turmeric-fed piglets, helping for better growth rate. Catabolism of turmeric polysaccharides provides energy for fermentative bacteria such as *Lactobacillus* spp. and *Clostridium* spp., which results in an increase in SCFA production (Peterson *et al.*, 2018) [19], which is the energy substrate for colonic epithelial cells (Zhao *et al.*, 2019) [28]. Since the antioxidant system of the body functions better as age advances (Yin *et al.*, 2013) [26], significant change was

not noticed in post-weaned group. Further, since late weaning (day 45) was practised in the experimental group, intensity of weaning stress and consequent oxidative damage might be less in this group. The TOC supplementation had no beneficial effect on the survival rate of piglets. Since the number of piglets included in the study is very limited, detailed study with larger sample size is required to make any generalisation.

5. Conclusion

Turmeric extract supplementation to sows during late pregnancy improved growth rate of their piglets in the postnatal life, probably due to higher milk production by the sows. Supplementation of turmeric extract to pre-weaned piglets improved their growth rate. The beneficial effects could be due to the antioxidant property of turmeric. Better nutrient digestion due to enhanced secretion of amylase, trypsin, chymotrypsin and lipase enzymes as well as better nutrient absorption in turmeric-fed piglets might also contribute to better performance in TOC fed pregnant sows and pre-weaned piglets. Promising results in the present study suggests potential use of turmeric as a natural growth promoter and effective substitute for antibiotics in swine feed.

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7. Conflict of Interest

The authors declare that they have no conflict of interest.

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