

Effects of Dietary Curcumin Supplementation on Growth Performance, Intestinal Morphology, and Antioxidant Status in Weaned Piglets: A Meta-Analysis

INPLASY202640054

doi: 10.37766/inplasy2026.4.0054

Received: 15 April 2026

Published: 15 April 2026

Song, WR; Chen, ZW; Liu, YD; Yang, YF; Wu, HY; Hu, P.

Corresponding author:

Ping Hu

70742@bvca.edu.cn

Author Affiliation:

Department of Animal Science and Technology, Beijing Vocational College of Agriculture.

ADMINISTRATIVE INFORMATION**Support** - This research received no external funding.**Review Stage at time of this submission** - Completed but not published.**Conflicts of interest** - None declared.**INPLASY registration number:** INPLASY202640054**Amendments** - This protocol was registered with the International Platform of Registered Systematic Review and Meta-Analysis Protocols (INPLASY) on 15 April 2026 and was last updated on 15 April 2026.**INTRODUCTION****Review question / Objective** P (Population): Weaned piglets (including both healthy weaned piglets and those with intrauterine growth restriction, IUGR)

I (Intervention): Dietary supplementation with curcumin or curcumin-related preparations

C (Comparator): Basal diet without curcumin supplementation

O (Outcomes): Growth performance: average daily gain (ADG), average daily feed intake (ADFI), feed conversion ratio (FCR)

Intestinal morphology: villus height (VH), crypt depth (CD), villus height-to-crypt depth ratio (VH:CD)

Antioxidant status: superoxide dismutase (SOD), glutathione peroxidase (GSH-Px), total antioxidant capacity (T-AOC), malondialdehyde (MDA)

S (Study design): Randomized controlled trials (RCTs).

Condition being studied Weaning is a critical stress period in pig production, characterized by

abrupt withdrawal of maternal support, dietary transition from liquid to solid, and environmental/social changes. These stressors commonly induce a condition known as weaning-associated stress syndrome, manifested as reduced feed intake, impaired growth performance, increased incidence of diarrhea, intestinal barrier dysfunction (villus atrophy, crypt hyperplasia, increased permeability), and oxidative stress. In more vulnerable populations such as piglets with intrauterine growth restriction (IUGR), these adverse effects are exacerbated. Curcumin, a natural polyphenolic compound derived from turmeric, was selected as the intervention of interest because of its well-documented antioxidant, anti-inflammatory, free radical-scavenging, and immunomodulatory properties, which directly counter the key pathophysiological features of weaning stress. Moreover, curcumin has shown potential to improve intestinal structure and redox status in livestock, making it a promising non-antibiotic feed additive for alleviating weaning-associated disorders.

METHODS

Participant or population Weaned piglets (including both healthy weaned piglets and piglets with intrauterine growth restriction, IUGR).

Intervention Dietary supplementation with curcumin or curcumin-related preparations.

Comparator Basal diet without curcumin supplementation.

Study designs to be included Randomized controlled trials (RCTs).

Eligibility criteria Studies were included in the meta-analysis if they met all of the following criteria: (1) the study population consisted of weaned piglets, including either healthy weaned piglets or piglets with intrauterine growth restriction (IUGR); (2) the intervention involved dietary supplementation with curcumin or curcumin-related preparations; (3) the study included a control group fed a basal diet without curcumin supplementation; (4) at least one outcome of interest was reported, including growth performance, intestinal morphology, or antioxidant-related indices.

Studies were excluded if they met any of the following criteria: (1) the animals were not weaned piglets; (2) curcumin was administered in combination with other functional additives and the independent effect of curcumin could not be distinguished; (3) the study lacked a control group; (4) the outcomes of interest were not reported; (5) data were insufficient for quantitative synthesis and could not be obtained or converted; or (6) the publication was a review, conference abstract, book chapter, duplicate publication, or other non-original study.

When multiple publications reported overlapping data from the same experiment, only the most complete or most informative dataset was retained. No restrictions were imposed on pig breed, sex, supplementation dose, or intervention duration.

Information sources The literature search and study selection were conducted in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines. A systematic search was performed in PubMed, Web of Science, Embase, Scopus, Wiley Online Library, and China National Knowledge Infrastructure (CNKI) for eligible studies published in English or Chinese from database inception to [March 1st, 2026]. To maximize the retrieval of relevant studies, combinations of Medical Subject

Headings (MeSH), free-text terms, and Boolean operators were used. The main search terms included: (Curcumin Phytosome OR Phytosome, Curcumin OR Diferuloylmethane OR Diferuloylmethane OR Turmeric Yellow OR Yellow, Turmeric OR Mervia OR Curcumin) AND (weaning pig OR weaned pig OR piglet). In addition, the reference lists of all eligible articles and relevant reviews were manually screened to identify any additional studies that may have been missed during the electronic search. A systematic search was conducted in PubMed, Web of Science, Embase, Scopus, Wiley Online Library, and China National Knowledge Infrastructure (CNKI) from database inception to March 1st, 2026. Reference lists of eligible articles and relevant reviews were also manually screened.

Main outcome(s) The extracted outcomes were categorized into three groups: growth performance, intestinal morphology and antioxidant status. Growth performance variables included average daily gain (ADG), average daily feed intake (ADFI), and feed conversion ratio (FCR). Intestinal morphology variables included villus height (VH), crypt depth (CD), and the villus height-to-crypt depth ratio (VH:CD). Antioxidant-related indices included superoxide dismutase (SOD), glutathione peroxidase (GSH-Px), total antioxidant capacity (T-AOC), and malondialdehyde (MDA). For each outcome, the mean value, sample size, and corresponding measure of variance were extracted for both the curcumin-supplemented group and the control group. When data were reported as standard error (SE), they were converted to standard deviation (SD) using the formula $SD = SE \times \sqrt{n}$. If outcomes were reported for different intestinal segments or tissues, the corresponding data were extracted separately where appropriate. When multiple curcumin doses were compared with a single control group, each eligible comparison was extracted separately. If numerical data were presented only in graphs, values were obtained from the figures whenever possible.

To ensure comparability across studies, units were standardized before quantitative synthesis when necessary. All extracted data were checked carefully prior to analysis, and any discrepancies in data coding or interpretation were resolved through repeated review of the original articles.

Quality assessment / Risk of bias analysis The SYRCLE's Risk of Bias tool for animal studies will be used to assess methodological quality. Two reviewers will independently evaluate ten domains: sequence generation, baseline characteristics, allocation concealment, random housing, blinding

of caregivers/investigators, random outcome assessment, blinding of outcome assessors, incomplete outcome data, selective outcome reporting, and other biases. Each domain will be rated as low, high, or unclear risk. Disagreements will be resolved by consensus or a third reviewer.

Strategy of data synthesis All statistical analyses were performed using Stata software (StataCorp, College Station, TX, USA). Meta-analyses were conducted to estimate the pooled effects of dietary curcumin supplementation on growth performance, intestinal morphology, intestinal barrier-related indices and antioxidant status in weaned piglets.

For continuous outcomes, effect sizes were expressed as mean difference (MD) or standardized mean difference (SMD) with corresponding 95% confidence intervals (CIs), depending on the consistency of measurement scales across studies. Because most outcomes were measured using different units, tissues, or analytical methods, SMD was used in the majority of analyses.

Between-study heterogeneity was assessed using Cochran's Q test and quantified with the I² statistic. I² values of 25%, 50%, and 75% were considered to represent low, moderate, and high heterogeneity, respectively. Given the expected variability among studies in terms of piglet health status, curcumin formulation, supplementation dose, and intervention duration, a random-effects model was applied for all analyses.

Subgroup analysis Subgroup analyses were conducted for the main growth performance outcomes, including average daily gain (ADG), average daily feed intake (ADFI), and feed conversion ratio (FCR). The predefined subgroup variables included health status, formulation, dose, and supplementation period. Health status was categorized as healthy piglets or intrauterine growth-restricted piglets. Formulation was grouped according to the type of curcumin-related preparation used in each study. Dose and supplementation period were categorized based on the distribution of the included data. These analyses were performed to explore potential sources of heterogeneity. A two-sided P value < 0.05 was considered statistically significant.

Sensitivity analysis Sensitivity analysis is not pre-specified as a core component of this meta-analysis due to the anticipated limited number of eligible studies and the exploratory nature of the review. However, if the number of studies for a given outcome is sufficient (e.g., ≥10), and notable heterogeneity is detected, post-hoc sensitivity

analyses may be explored on an ad-hoc basis. Potential approaches could include leave-one-out analysis or comparison between fixed-effects and random-effects models, but these will be clearly labelled as exploratory. No formal sensitivity analysis is guaranteed, and any such analyses will be interpreted with caution given the risk of over-interpretation in small meta-analyses.

Country(ies) involved China.

Keywords curcumin; weaned piglets; growth performance; intestinal morphology; antioxidant status; meta-analysis.

Contributions of each author

Author 1 - Wanrong Song.

Author 2 - Zhengwei Chen.

Author 3 - Yiduo Liu.

Author 4 - Yifei Yang.

Author 5 - Haiyan Wu.

Author 6 - Ping Hu.