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Palm kernel meal (PKM) is a by-product of palm kernel oil extraction, primarily produced in Southeast Asia, with Malaysia and Indonesia being the largest producers. Due to its substantial price advantage, low mycotoxin risk, and relatively stable quality, China has imported large quantities of PKM in recent years as a substitute for soybean meal, and it has been widely used in poultry diets. This review summarizes the chemical composition, metabolizable energy value, amino acid digestibility, and poultry production applications of PKM.

Full Text

Nutritive Value and Application of Palm Kernel Meal in Poultry Feed¹

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Abstract

Palm kernel meal (PKM), a by-product of palm kernel oil extraction, is primarily produced in Southeast Asia, with Malaysia and Indonesia being the largest producers. Due to its competitive pricing, low mycotoxin risk, and relatively stable quality, China has imported PKM in large quantities in recent years as a substitute for soybean meal, and it has been widely used in poultry diets. This article reviews the chemical composition, metabolizable energy value, amino acid digestibility, and application in poultry production of PKM.

Keywords: palm kernel meal; chemical composition; metabolizable energy; amino acid digestibility; poultry; application

Palm kernel meal (PKM) is a by-product of palm kernel oil extraction, characterized by its brown color and chocolate-like aroma. Currently, PKM is primarily produced through two processing methods: expeller pressing and solvent extraction (SE). The expeller method offers advantages such as simple equipment and low production costs, making it the dominant processing approach. As China's feed nutrition database does not yet contain PKM data, conventional composition data from international databases are summarized in Table 1. Expeller-pressed PKM retains higher residual crude fat (ether extract, EE) content, ranging from 6.5% to 9.1%, whereas solvent-extracted PKM contains only 1.6% to 2.5% EE. The American Feedstuff database shows that PKM from Brazil has notably higher crude protein (CP) and crude ash (Ash) contents but lower acid detergent fiber (ADF) compared to other databases, likely due to differences in raw material origin and processing technology. PKM contains substantial amounts of hull, resulting in high fiber content that somewhat limits its application in poultry diets. According to international databases, PKM contains 16.1% to 20.4% crude fiber (CF), 54.2% to 65.8% neutral detergent fiber (NDF), and 62.1% to 65.8% non-starch polysaccharides (NSP).

1 Metabolizable Energy (ME) Value

Due to its high CF content, PKM has relatively low ME values. Generally, EE content in PKM positively correlates with ME value, while CF and NDF contents show negative correlations. Alimon [4] determined the ME values of three PKM types through animal experiments (Table 2). The three PKM samples had the following CP, CF, EE contents and apparent metabolizable energy (AME) values: CP at 14.50%, 16.60%, and 19.24%; CF at 10.00%, 12.29%, and 17.96%; EE at 9.48%, 7.59%, and 1.30%; and AME at 11.11, 10.14, and 7.61 MJ/kg, respectively. The first two PKM types were produced by expeller pressing with similar nutritional profiles, showing higher EE content and ME values, while the third type was solvent-extracted with lower EE and ME values [3]. Regression analysis of these data revealed strong linear correlations between ME value and EE or CF content. The regression formula for AME value (y) and EE content (x) was $y = 100.82x + 1,680.7$ ($R^2 = 0.9977$), while the formula for AME value (y) and CF content (x) was $y = -105.48x + 3,713.2$ ($R^2 = 0.9998$). Within certain ranges, each 1% increase in EE content raises AME value by approximately 0.42 MJ/kg, whereas each 1% increase in CF content reduces AME value by about 0.44 MJ/kg.

Alimon [4] reported considerable variation in conventional indices and ME values among different PKM sources, with CF content ranging from 13.0% to 20.0%, NDF from 66.8% to 78.9%, EE from 5% to 8%, and ME values from 6.49 to 7.51 MJ/kg. Abdollahi et al. [5] determined PKM's AME value at 5.48 MJ/kg using the indicator method. These reported differences in PKM ME values primarily relate to variations in palm kernel shell content, processing technology, and experimental conditions.

2 Amino Acid (AA) Composition and Digestibility

A comparison of AA content and digestibility between PKM and soybean meal is presented in Table 3. For essential amino acids (EAA), PKM contains 0.37% lysine (Lys), 0.30% methionine (Met), 0.19% cystine (Cys), 0.44% threonine (Thr), and 1.61% arginine (Arg), with digestibility values of 90.3%, 91.5%, 46.7%, 68.1%, and 86.6%, respectively. Compared to soybean meal, PKM has lower Lys and Thr contents; for instance, Lys and Thr represent 2.3% and 2.8% of CP in PKM versus 6.2% and 3.9% in soybean meal. Conversely, PKM has higher Arg content, while Met and Cys contents are similar to soybean meal. Regarding digestibility, PKM's CP digestibility is substantially lower than soybean meal at only 46.3% compared to 85.0%. PKM's total AA digestibility is 75.0%, with Cys digestibility particularly low at 46.7%, though other essential AA digestibility values are relatively high. Due to low CP digestibility in PKM, formulation should consider not only dietary CP level but also AA content and digestibility, requiring supplementation with crystalline AA to ensure satisfactory feeding results. Additionally, enzyme supplementation is commonly used in practical production to improve feed utilization efficiency, which also enhances CP and AA utilization.

Li Yupeng et al. [6] investigated the effects of mannanase and mannanase plus protease treatment of PKM on ileal AA digestibility in broiler chickens. Results showed both enzyme treatments significantly improved apparent ileal digestibility of CP and most AA (except Cys), with the mannanase plus protease combination increasing apparent protein digestibility by 2.66 percentage points compared to mannanase alone.

3.1.1 Dosage and Growth Performance

Most research indicates that PKM inclusion at 10% to 20% in broiler diets does not negatively affect weight gain [7-9], with some studies demonstrating levels up to 30% are feasible [10-11]. However, excessive inclusion may increase feed intake and elevate feed-to-gain ratio, likely due to PKM's high fiber content reducing nutrient digestibility and utilization efficiency [12]. Additionally, substantial variation in PKM's ME value due to origin and processing technology can lead to underestimation of dietary ME, causing broilers to increase feed intake to meet energy requirements and consequently reducing feed conversion efficiency. Notably, recommended PKM inclusion levels differ by growth stage, primarily related to gut development and tolerance to high-fiber diets. Saenphoom et al. [8] found that including over 5% palm kernel meal in starter diets significantly reduced growth performance and feed conversion, whereas 20% inclusion in finisher diets had no negative effects. In another study, 28% palm kernel meal in starter diets significantly impaired feed conversion, while 35% inclusion in finisher diets did not affect growth performance [11]. Jiménez-Moreno et al. [13] suggested that appropriate dietary fiber content in young poultry can improve growth performance, but excessive fiber diminishes these benefits. Beyond gut functional differences, variations in hindgut microbial composition rep-

resent an important factor affecting fiber utilization differences among poultry [14].

3.1.2 Enzyme Preparations

PKM contains up to 60% NSP, primarily mannan, cellulose, xylan, and pectin, which limits its application in animal production. Dietary enzyme supplementation can improve its utilization efficiency. Research shows that mannanase treatment of PKM significantly improves ileal digestibility of CP and most AA [6]. Adding xylanase and mannanase to diets containing palm kernel meal significantly improved growth performance and digestibility of CP, nitrogen-free extract, and energy in yellow-feathered broilers [15]. Exogenous enzyme pretreatment of PKM reduced hemicellulose and cellulose contents by 26.26% and 32.62%, respectively, while increasing true metabolizable energy (TME) and nitrogen-corrected true metabolizable energy (TME_n) by 38% and 33% [8]. Aya et al. [9] reported that feeding broilers a diet containing 10% PKM significantly impaired weight gain, feed intake, and feed conversion, but mannanase supplementation restored growth performance to control levels. Thus, enzymes improve nutrient utilization by degrading NSP and other anti-nutritional factors, enabling higher PKM inclusion rates. Similar results were observed by Guo Quankui et al. [16], who reported significant improvements in feed-to-gain ratio when feeding broilers a diet with 30% PKM supplemented with mannanase.

3.1.3 Intestinal Health and Immunity

PKM contains high levels of oligosaccharides that play a role in maintaining intestinal microflora and improving gut health. Studies on the effects of PKM and mannan-oligosaccharides on cecal microbiota showed that feeding chicks PKM-containing diets reduced *Salmonella enteritidis* colonization [17-18], significantly increased beneficial bacteria such as *Bifidobacterium*, and decreased harmful *Escherichia coli* populations [18]. Similar effects were observed with dietary PKM extract supplementation. Fernandez et al. [19] found that both mannan-oligosaccharides and PKM effectively protected intestinal mucosa and interfered with *Salmonella* colonization. Additionally, PKM improved intestinal function by reducing digesta viscosity [15] and increasing villus height [8], thereby enhancing nutrient utilization and reducing nitrogen excretion in feces [20]. Beyond gut health benefits, PKM also improved immune function in broilers, including increasing Newcastle disease antibody titers, phagocytic activity, and immune organ indices (spleen, bursa, and thymus) [15], while reducing heterophil and basophil counts [21]. Injection of PKM extract also increased serum and liver immunoglobulin G (IgG) content and antioxidant capacity [22], protecting liver from heat stress damage [23].

3.2 Laying Hens

Research indicates that PKM inclusion up to 35% in pullet diets does not affect weight gain but increases feed intake and feed-to-gain ratio [24]. In practice,

wheat bran is commonly used as a filler in breeder or pullet diets, but it offers poor cost-effectiveness, readily absorbs moisture, and carries high mycotoxin risk. With low moisture content, minimal toxin risk, and low energy value, PKM serves as an ideal nutritional diluent and substitute for wheat bran in pullet diets. Laying hens with fully developed digestive systems can effectively utilize PKM, with inclusion levels of 30% to 40% showing no negative effects on egg production, yolk content, shell thickness, or Haugh unit; however, levels exceeding 40% significantly reduce laying rate, feed intake, feed conversion, and egg weight [25-26]. Notably, high PKM inclusion may lighten yolk color [27], likely due to low pigment content. Adding 6% to 10% palm kernel meal to peak-production layer diets significantly improved egg weight, feed-to-egg ratio, and cracked/misshapen egg rate [28], attributed to improved gut health and nutrient digestibility.

4 Issues Needing Attention

Due to substantial variation in origin and processing technology, PKM shows considerable nutrient variability, requiring careful parameter setting during application. Because of low ME, CP, and AA digestibility, diets should be supplemented with additional oil to ensure adequate energy levels and crystalline AA to balance dietary amino acids. Furthermore, PKM inclusion levels should be carefully controlled for young poultry, with enzyme supplementation considered to improve utilization. When used in layer diets, pigment issues require attention; PKM should be combined with pigment-rich ingredients such as corn or corn gluten meal, or commercial pigments should be added to prevent reduced yolk color and egg quality.

5 Summary

PKM offers advantages including high cost-effectiveness, low toxin risk, and benefits for gut health and immune function, making it widely applicable in broiler and layer diets for reducing formulation costs and stabilizing production performance. When using PKM, proper setting of ME values and AA digestibility parameters is essential, and enzyme supplementation should be added to mitigate negative effects of NSP, ensuring optimal utilization.

References

- [1] CVB. *Chemical composition and nutritional values of feedstuffs*[M]. [S.l.]: [s.n.], 2016.
- [2] SAUVANT D, PEREZ J M, TRAN G. *Tables of composition and nutritional value of feed materials: pig, poultry, sheep, goats, rabbits, horses, fish*[M]. Paris: INRA, 2004.
- [3] EZIESHI E V, OLOMU J M. Nutritional evaluation of palm kernel meal types: 1. Proximate values and metabolizable energy composition[J]. *African*

Journal of Biotechnology, 2007, 6(21): 2484-2486.

[4] ALIMON A R. The nutritive value of palm kernel cake for animal feed[J]. *Palm Oil Developments*, 2005, 40: 12-13.

[5] ABDOLLAHI M R, HOSKING B, RAVINDRAN V. Nutrient analysis, metabolisable energy and ileal amino acid digestibility of palm kernel meal for broilers[J]. *Animal Feed Science and Technology*, 2015, 206: 119-125.

[6] 李玉鹏, 刘醒醒, 唐德富, 等. 酶解棕榈仁粕肉仔鸡氨基酸营养价值的评定 [J]. *中国饲料*, 2017(2): 29-34, 39.

[7] SOLTAN M A. Growth performance, immune response and carcass traits of broiler chicks fed on graded levels of palm kernel cake without or with enzyme supplementation[J]. *Livestock Research for Rural Development*, 2009, 21(3): 536-547.

[8] SAENPHOOM P, LIANG J B, HO Y W, et al. Effects of enzyme treated palm kernel expeller on metabolizable energy, growth performance, villus height and digesta viscosity in broiler chickens[J]. *Asian-Australasian Journal of Animal Sciences*, 2013, 26(4): 537-544.

[9] AYA V E, AYANWALE B A, IJAIYA A T, et al. Performance and nutrient digestibility in broiler chicks as influenced by multienzyme addition to starter diets containing palm kernel meal[J]. *Biotechnology in Animal Husbandry*, 2013, 29(1): 93-104.

[10] EZIESHI E V, OLOMU J M. Nutritional evaluation of palm kernel meal types: 2. Effects on live performance and nutrient retention in broiler chicken diets[J]. *African Journal of Biotechnology*, 2008, 7(8): 1171-1175.

[11] ONWUDIKE O C. Palm kernel meal as a feed for poultry. 3. Replacement of groundnut cake in broiler diets[J]. *Animal Feed Science and Technology*, 1986, 16(3): 195-202.

[12] OGBONNA J U, LONGE O G, LEGEL S. Investigations of the digestibility of proximate composition in commercial palm kernel meal in broiler chick rations[J]. *Archives of Animal Nutrition*, 1988, 38(3): 215-219.

[13] JIMÉNEZ-MORENO E, GONZÁLEZ-ALVARADO J M, GONZÁLEZ-SERRANO A, et al. Effect of dietary fiber and fat on performance and digestive traits of broilers from one to twenty-one days of age[J]. *Poultry Science*, 2009, 88(12): 2562-2574.

[14] WALUGEMBE M, HSIEH J C F, KOSZEWSKI N J, et al. Effects of dietary fiber on cecal short-chain fatty acid and cecal microbiota of broiler and laying-hen chicks[J]. *Poultry Science*, 2015, 94(10): 2351-2359.

[15] 张兴, 何仁春, 夏中生, 等. 小麦-豆粕-棕榈粕型饲料添加 NSP 酶饲喂黄羽肉鸡的效果研究 [C]//第七届中国饲料营养学术研讨会论文集. 郑州: 中国农业大学出版社, 2014: 144.

- [16] 郭全奎, 王璐菊. 棕榈仁粕饲料中添加甘露聚糖酶对肉仔鸡生产性能的影响 [J]. 畜牧兽医学杂志, 2017, 36(6): 29-31.
- [17] ALLEN V M, FERNANDEZ F, HINTON M H. Evaluation of the influence of supplementing the diet with mannose or palm kernel meal on Salmonella colonisation in poultry[J]. *British Poultry Science*, 1997, 38(5): 485-488.
- [18] FERNANDEZ F, HINTON M, VAN GILS B. Dietary mannan-oligosaccharides and their effect on chicken caecal microflora in relation to Salmonella enteritidis colonization[J]. *Avian Pathology*, 2002, 31(1): 49-58.
- [19] FERNANDEZ F, HINTON M, VAN GILS B. Evaluation of mannan-oligosaccharides on the competitive exclusion of Salmonella enteritidis colonization in broiler chicks[J]. *Avian Pathology*, 2000, 29(6): 575-581.
- [20] YUSRIZAL Y, ANGEL R, ADRIZAL A, et al. Feeding native laying hens diets containing palm kernel meal with or without enzyme supplementations. 2. Excreta nitrogen, ammonia, and microbial counts[J]. *The Journal of Applied Poultry Research*, 2013, 22(2): 269-278.
- [21] REZAEI S, FASELEH J M, LIANG J B, et al. Effect of oligosaccharides extract from palm kernel expeller on growth performance, gut microbiota and immune response in broiler chickens[J]. *Poultry Science*, 2015, 94(10): 2414-2420.
- [22] JAHROMI M F, SHOKRYAZDAN P, IDRUS Z, et al. In ovo and dietary administration of oligosaccharides extracted from palm kernel cake influence general health of pre- and neonatal broiler chicks[J]. *PLoS One*, 2017, 12(9): e0184553.
- [23] OSKOEIAN E, ABDULLAH N, IDRUS Z, et al. Palm kernel extract exerts hepatoprotective activity in heat-induced oxidative stress in chicken hepatocytes[J]. *BMC Complementary and Alternative Medicine*, 2014, 14: 368.
- [24] ONWUDIKE O C. Palm kernel meal as a feed for poultry. 2. Diets containing palm kernel meal in grower pullet diets[J]. *Animal Feed Science and Technology*, 1986, 16(3): 187-194.
- [25] ONWUDIKE O C. Palm kernel meal as a feed for poultry. 4. Use of palm kernel meal by laying birds[J]. *Animal Feed Science and Technology*, 1988, 20(4): 279-286.
- [26] PEREZ J F, GERAT A G, MURILLO J G. Research notes: the effect of different levels of palm kernel meal in layer diets[J]. *Poultry Science*, 2000, 79(1): 77-79.
- [27] ADRIZAL A, YUSRIZAL Y, FAKHRI S, et al. Feeding native laying hens diets containing palm kernel meal with or without enzyme supplementations: 1. Feed conversion ratio and egg production[J]. *The Journal of Applied Poultry Research*, 2011, 20(1): 40-49.

[28] 谢正军, 金征宇, 殷福珊, 等. 棕榈粕在蛋鸡日粮中的应用研究 [J]. 饲料工业, 2006, 27(7): 36-38.

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