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抗氧化剂对 DDGS 中油脂和提炼玉米油在高温高湿环境下油脂过氧化的影响

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本试验研究了抗氧化剂、DDGS 油脂含量、提炼玉米油质量、储存时间对油脂过氧化的影响。试验共选取 4 个样品，一个低油 DDGS（LO-DDGS，5.0%粗脂肪），一个高油 DDGS（HO-DDGS，13.0%粗脂肪），以及 2 个提炼玉米油（DCO-1 和 DCO-2，水分、不溶性杂质、非皂化物含量分别为 1.20、0.08、0.48%和 1.20、0.01、0.1%)。将每个样品分为 18 个小样，每个 DDGS 小样约 908g，提炼玉米油小样约 2kg。随机分为 3 个处理组，对照组（无抗氧化剂添加）、Rendox-CQ（REN 组，1000 mg/kg 粗脂肪）、Santoquin-Q4T（SAN 组，1500mg/kg 粗脂肪）。小样混匀后分为三份，一份立即-20℃冷冻（初始值），另两份在高温高湿环境下（38.6±0.1℃，94.0±0.3%相对湿度）分别保存 14 和 28 天。运用 SAS 的混合模型，以初始值为协变量，分析原料、抗氧化剂、储存时间对过氧化的影响及影响因子之间的互作。当储存时间从 14 天延长至 28 天时，提炼玉米油和 DDGS 的过氧化值（PV）、茴香胺值（AnV）、硫代巴比妥酸反应产物（TBARS）增加了 3-4 倍（P＜0.05）。储存 28 天后，提炼玉米油-1 和高油 DDGS 的过氧化值（分别为 12.3±0.3 和 12.6±0.3mEq O_2/kg 油）高于提炼玉米油-2 和低油 DDGS（9.6±0.3 和 9.3±0.3mEq O_2/kg 油）。TBARS（对照组为 11.0±0.2 mg 丙二醛 Eq/kg 油）和茴香胺值（AnV，对照组为 6.5±0.2）在添加 REN 和 SAN 抗氧化剂组中均有降低（P< 0.05）。但是抗氧化剂组之间 TBARS 和 AnV 差异并不显著，REN 和 SAN 组的 TBARS 分别为 6.1±0.2、5.9±0.2mg 丙二醛 Eq/kg 油，AnV 分别为 1.9±0.2、1.8±0.2。储存 14 天和 28 天后，原料的过氧化值在添加抗氧化剂后有显著降低（对照组为 16.0 mEq O_2/kg），并且 SAN 组过氧化值高于 REN 组（分别为 8.8±0.2、8.0±0.2 mEq O_2/kg）。总之，DDGS 和提炼玉米油在 38.6℃和 94.0%相对湿度储存 28 天情况下添加抗氧化剂能减少一半过氧化，但是均不能完全消除过氧化。

Impact of synthetic antioxidants on lipid peroxidation of distiller's dried grains with solubles and distiller's corn oil stored under high temperature and humidity conditions

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This experiment evaluated the effect of antioxidants, oil content in distiller's dried grains with solubles (DDGS), quality of distiller's corn oil, and storage time on lipid peroxidation. A source of low-oil DDGS (LO-DDGS; 5.0% ether extract [EE], as-fed basis), high-oil DDGS (HO-DDGS; 13.0% EE, as-fed basis), and 2 sources of distiller's corn oil (DCO; 1.20, 0.08, and 0.48% moisture, insoluble impurities, and unsaponifiables [MIU], respectively [DCO-1], and 1.20, 0.01, and 0.10% MIU, respectively [DCO-2]) were obtained. Each of the 4 ingredients was divided into 18 representative subsamples (approximately 908 g for DDGS or 2 kg of DCO). Six subsamples of each ingredient were mixed with either no supplemental antioxidants (CON), Rendox-CQ (REN; 1,000 mg/kg EE; Kemin, Industries, Des Moines, IA), or Santoquin-Q4T (SAN; 1,500 mg/kg EE; Novus International, St. Louis, MO). Each mixture (n = 72) was split into thirds, and 1 portion was immediately frozen at –20°C (d 0). Two portions were stored under hot (38.6 ± 0.1°C) and humid conditions (94.0 ± 0.3% relative humidity) for 14 or 28 d. The MIXED procedure of SAS was used to evaluate the effects of ingredient, antioxidant, storage time, and interactions, with d-0 values used as a covariate. From d 14 to 28, peroxide value (PV), p-anisidine value (AnV), and thiobarbituric acid reactive substances (TBARS) of DCO and DDGS increased by 3- to 4-fold (P < 0.05). Over the entire storage period, PV of DCO-1 and

HO-DDGS (12.3 ± 0.3 and 12.6 ± 0.3 mEq O2/kg oil, respectively) exceeded ($P < 0.05$) that of DCO-2 and LO-DDGS (9.6 ± 0.3 and 9.3 ± 0.3 mEq O2/kg oil, respectively). Adding REN or SAN ($P < 0.05$) reduced TBARS and AnV relative to CON (TBARS = 11.0 ± 0.2 mg malondialdehyde Eq/kg oil and AnV = 6.5 ± 0.2) over the entire period (mean of d 14 and 28), but TBARS and AnV did not differ ($P > 0.05$) between antioxidants (TBARS = 6.1 ± 0.2 and 5.9 ± 0.2 mg malondialdehyde Eq/kg oil, respectively, and AnV = 1.9 ± 0.2 and 1.8 ± 0.2 for REN and SAN, respectively). The PV on d 14 and 28 and overall was less ($P < 0.05$) when either antioxidant was added relative to CON (16.0 mEq O2/kg) and was greater for ingredients treated with SAN ($P < 0.05$) compared with REN (8.8 ± 0.2 and 8.0 ± 0.2 mEq O2/kg oil for SAN and REN, respectively). In summary, antioxidants reduced peroxidation of DDGS and DCO by approximately 50% during 28 d of storage at 38.6°C and 94.0% relative humidity, but neither antioxidant completely stabilized the ingredients.