SHORT COMMUNICATION

Extraction and composition characterisation of amino acids from tung meal

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The most desirable content of amino acids (AAs) in the extracted products from tung (Aleurites fordii) meal was 93.88%, which was obtained from shelled tung meal at a hydrolysis temperature of 45°C and a isoelectric precipitation pH value of 4.4. Furthermore, the cytotoxic activity of extracted AAs was also evaluated by MTT assay. Antioxidant activity of extracted AAs was also measured by the DPPH assay. As a result, the high yield of extracted AAs exhibited so low cytotoxic and high antioxidant activity that had the potential use as a functional ingredient.

Keywords: amino acids; tung meal; cytotoxic activity; antioxidant activity

1. Introduction

Tung tree (Aleurites fordii) is essentially a native plant produced from oriental countries, especially China. It can yield tung oil consisting of highly unsaturated fatty acids and a few saturated fatty acids. The application of tung oil was increasingly developed in many fields (Wang & Padua 2005; Chen et al. 2010; Li et al. 2010; Shang et al. 2010; Kundu & Larock 2011).

Free amino acids (AAs) could be extracted from some plants such as potato (Galdón et al. 2010), agrocybe chaxingu (Lee et al. 2011), rice bran (Sereewatthanawut et al. 2008) and gum karaya (Anderson et al. 1985). However, the reported results showed that the highest yield of total AAs was less than 50% of the dried product. To the best of our knowledge, the study on the extraction of high content of AAs from tung meal as the nutritive additive in feedstuffs has rarely been reported.

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2 Results and discussion

2.1 Composition analysis of deoiled tung meal

According to the results, the percentage content of crude protein in tunnelling microscopy (STM) reached 40.20%, while the percentage content of crude protein in ultrafast scanning tunnelling microscope (USTM) was only 17.30%. The contents of crude protein in STM were obviously higher than those in USTM.

2.2 Effect of temperature and pH value

From Figure S1a it can be seen that the contents of total AAs extracted from STM increased with the increase of pH value from 3.0 to 4.4, especially the content of AAs hydrolysed at 45°C increased and the percentages of AAs reached 93.88% at a precipitation pH value of 4.4. The contents of total AAs extracted from USTM showed the same changed trend as those extracted from STM with the increase of pH value as seen in Figure S1b. The reason that the amount of AAs was highest at a hydrolysis temperature of 45°C may be that Maillard reaction could occur between carbonyl of sugar and amidogen of AAs during the hydrolysis of tung meal at a higher hydrolysing temperature (Koutinas et al. 2007; Goldmann et al. 2009) and therefore could not provide enough energy for hydrolysis of crude protein at a lower hydrolysing temperature. In addition, we can see from Figure S2 that the hydrolysis temperature and precipitation pH had obvious effect on yield of AAs extracted from tung meal.

2.3 Composition of AAs

Table S1 shows the composition of AAs extracted from STM and USTM at a hydrolysis temperature of 45°C and a precipitation pH value of 4.4. It can be seen that the contents of AAs except for Cys extracted from STM were generally high, and especially percentages of Thr and Arg exceeded 10%. However, at the same extraction condition the content of total AAs extracted from USTM was reduced to 72.45%. It suggests that the composition of extracted AAs was directly influenced by the shell of tung kernels containing crude fibre during hydrolysis (Buňka et al. 2009).

In order to further analyse the composition of extracted products, Figure S3 shows GC-MS chromatograms of the fatty acids in tung meal and extracted AAs. According to the area calculation of chromatographic peaks, the contents of $\alpha$-C$_{18:3}$ and unsaturated fatty acids in fatty acids of STM were 80.30% and 95.05%, respectively. However, it cannot be obviously seen that the peaks of residual fatty acids in AAs extracted from STM from Figure S3a. By contrast, the content of residual fatty acids in AA extracted from USTM reached 2.59% as seen in Figure S3b. In addition, the contents of $\alpha$-C$_{18:3}$ and unsaturated fatty acids in fatty acids of USTM were 75.64% and 93.84%, respectively.

2.4 Cytotoxicity assay of AAs

Figure S4 shows viability of Caco-2 cells incubated with AAs extracted from STM and USTM at a temperature of 45°C and pH value of 4.4. There is evidence that the cell viability increased before 8 h incubation with AAs and reduced subsequently. Viability of Caco-2 cells incubated with AAs extracted from STM at 8 and 48 h was 122% and 86%. However, the viability of cells incubated with AAs extracted from USTM was lower than that incubated with AAs extracted from STM at the same incubated time. For example, the cell viability increased from 106% to 109% with the increase of incubated time from 4 to 8 h, and decreased to 73% after 48 h incubation.
2.5 Antioxidant activity of AAs

As shown in Figure S5, DPPH free radical scavenging activity and hydroxyl radical scavenging activity of AAs extracted from STM at a temperature of 45°C and pH value of 4.4 was 78.5% and 70.3%. However, the two scavenging activity of AAs extracted from USTM at a temperature of 45°C and pH value of 4.4 was 70.7% and 60.4%, respectively.

In addition, antioxidant activity assay of AAs extracted from tung meal as one of the byproducts of tung tree shows the important result that the extracted AAs are particularly suitable for use as nutritive additive in feeds or foods, also as ingredient in medicine and cosmetics (Carmona-Jiménez et al. 2014). Results of the DPPH assay free radical scavenging activity and hydroxyl radical scavenging activity of AAs extracted from STM and USTM at a temperature of 45°C and pH value of 4.4 all showed the antioxidant activity.

3. Conclusion

According to our results, the percentages of total AAs and essential AAs in the products extracted from STM at a hydrolysis temperature of 45°C and a precipitation pH value of 4.4 reached 93.88% and 45.46%, respectively. Moreover, based on the desirable cytotoxicity and antioxidant activity of the extracted AAs, tung meal should be regarded as a good byproduct of tung tree for supplying the functional ingredient.

Supplementary material

Supplementary materials associated with this article are available online at http://dx.doi.org/10.1080/14786419.2015.1062007.

Disclosure statement

No potential conflict of interest was reported by the authors.

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References

Anderson DMW, Howlett JF, McNab CGA. 1985. The amino acid composition of the proteinaceous component of gum karaya (Sterculia spp.). Food Addit Contam. 3:153–157.

Buňka F, Kríž O, Veličková A, Buňková L, Kráčmar S. 2009. Effect of acid hydrolysis time on amino acid determination in casein and processed cheeses with different fat content. J Food Compos Anal. 22:224–232.

Carmona-Jiménez Y, García-Moreno MV, Igartuburu JM, Barroso CG. 2014. Simplification of the DPPH assay for estimating the antioxidant activity of wine and wine by-products. Food Chem. 165:198–204.

Chen YH, Chen JH, Chang CY, Chang CC. 2010. Biodiesel production from tung (Vernicia montana) oil and its blending properties in different fatty acid compositions. Bioresour Technol. 101:9521–9526.

Galdón BR, Mesa DR, Rodríguez EMR, Romero CD. 2010. Amino acid content in traditional potato cultivars from the Canary Islands. J Food Compos Anal. 23:148–153.

Goldmann T, Davidek T, Gouezee E, Blank I, Bertholet MC, Stadler R. 2009. Formation of styrene during the maillard reaction is negligible. Food Addit Contam. 26:583–594.

Koutinas AA, Arifeen N, Wang R, Webb C. 2007. Cereal-based bio refinery development: integrated enzyme production for cereal flour hydrolysis. Biotechnol Bioeng. 97:61–72.

Kundu PP, Larock RC. 2011. Montmorillonite-filled nanocomposites of tung oil/styrene/divinylbenzene polymers prepared by thermal polymerization. J Appl Polym Sci. 119:1297–1306.

Lee KJ, Yun IJ, Kim KH, Lim SH, Ham HJ, Eum WS, Joo JH. 2011. Amino acid and fatty acid compositions of Agrocybe chaxingu, an edible mushroom. J Food Compos Anal. 24:175–178.
Li L, Lv P, Luo W, Wang Z, Yuan Z. 2010. Esterification of high FFA tung oil with solid acid catalyst in fixed bed reactor. Biomass Bioenerg. 34:496–499.
Sereewatthanawut I, Prapintip S, Watchiraruji K, Goto M, Sasaki M, Shotipruk A. 2008. Extraction of protein and amino acids from deoiled rice bran by subcritical water hydrolysis. Bioresource Technol. 99:555–561.
Shang Q, Jiang W, Lu H, Liang B. 2010. Properties of tung oil biodiesel and its blends with 0# diesel. Bioresour Technol. 101:826–828.
Wang Q, Padua GW. 2005. Properties of zein films coated with drying oils. J Agric Food Chem. 53:3444–3448.