C: with pork back-fat; T1: 2% soy protein isolate; T2: 4% soy protein isolate. [a-c] Different parameter superscripts in the figure indicate significant differences ($p < 0.05$).

The result showed that the hardness and springiness was significantly ($p < 0.05$) increased when added 2% soy protein isolate, but they were significantly ($p < 0.05$) decreased when added 4% soy protein isolate. Overall, the addition of 2% soy protein isolate combined with high pressure processing are able to produce the pork meat batter with textural properties.

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ADVANCES IN RESEARCH ON ANTIOXIDANT ACTIVITY OF TANNIC ACID

Tannic acid, is a polyphenolic compound found in plant tissues such as persimmon, tea, coffee, pomegranate, and sorghum. The structure of tannic acid is very complex and belongs to polyhydroxyphenols compound. Tannins are also associated with astringency in foods and feeds. Moreover, tannic acid can form a precipitate in combination with proteins, alkaloids, pectin, etc., and has therefore been considered as an anti-nutritional factor in feed (Pan Xiancai et al. 2013), this may be related to the ability of tannic acid to interact with digestive enzymes in animals, but this anti-nutrition can only be the result of certain tannins at high doses. While at low doses, tannins have a positive effect on the nutrition and health of the animal. A large number of studies in recent years have shown that tannins have many benefits for human health. Tannin has a variety of biological activities, including anti-oxidation, cardiovascular protection, anti-inflammatory, anti-cancer, anti-viral, anti-bacterial, and improve intestinal micro-ecological environment. The various health effects have been documented in recent years by using synthetic antioxidants (Shahidi, Janita, Wanasundara, 1992). There are growing concern on exploiting natural antioxidants due to their safety, consumer acceptability. This article focuses on the antioxidant activity of tannic acid and its application prospects in extending the shelf life of foods.

Tannic acid has strong in vitro antioxidant activity. The phenolic hydroxyl group itself has strong reducibility and is also the main active group of tannins. Therefore, tannins possess potent antioxidant activities

which have been widely reported. According to the in vitro antioxidant test, the clearance rates of pure 0.01mg/mL tannic acid were 92.13% vs 65.58% for 1,1-diphenyl-2-picryl hydrazyl (DPPH) and hydroxyl radical (OH·), significantly superior to that of ascorbic acid. It was found that condensed tannins (CTs) extracted from *Leucaena leucocephala* represented higher in vitro antioxidant activities (2257.12±80.55 mg TEAC/g CTs, 605.3±1.82 mg TEAC/g CTs and 1014.03±1.20 mg TEAC/g CTs in ferric reducing antioxidant power (FRAP), 2,2'-azino-bis(3-ethylbenzothiazoline-6-sulphonic acid) (ABTS) and DPPH assay, respectively) (Mazni Abu Zarin Ho Yin Wan Azizul Isha et al., 2016). Our previous study found the corresponding IC_{50} values of tertiary butylhydroquinone (TBHQ) was higher than that of tannic acid. It was believed that the galloyl groups of tannic acid exhibited higher hydrogen- and electron- donating capacities than that of TBHQ. However, tannic acid reprensented lower antioxidant activity in linoleic acid system than that of TBHQ, which attributed to its poor hydrophobicity.

Sajid Maqsood et al. compared the antioxidant activities of catechins, caffeic acid, ferulic acid and tannic acid and found that tannic acid exhibited the highest DPPH and ABTS free radical scavenging activity as well as FRAP. The effects of the four different phenolic compounds on the lipid oxidation of menhaden oil-in-water emulsion and its mince were also investigated. For both model systems, the results showed that tannic acid at level of 100 mg/l exhibited the highest efficiency in reducing lipid oxidation (Sajid Maqsood and Soottawat Benjakul, 2010).

In recent years, tannic acid was considered to be the most potential natural antioxidants in many beverages and plant-based foods, and inveatigators also found tannic acid can control the oxidation of fish oil-in-water emulsions and fish mince. Furthermore, due to the function of phenolic and aliphatic hydroxyl groups, tannins have been used to develop new biobased polymers by chemical modification. (Alice Arbenz et al., 2015, Danny E. et al., 2015). In the future, tannic acid may be used as natural antioxidant in water-in-oil food systems after improving its hydrophobicity by means of chemical modification. However the antioxidant mechanism of tannic acid is not fully clarified, therefore, It still needs further investigation.