The Potency of Locally Available Orange Peel Essential Oil as A Feed Additive to Improve Performances of Poultry

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Abstract. Indonesia as a tropical country has several orange varieties grown in the archipelago. The peel which contributes about 10 – 14% of the whole orange, is a potential waste to be utilized for making essential oil useful as an Antibiotic Growth Promoter (AGP) for poultry. Therefore, elaborative research is needed, because there are about 258 oranges from the genus citrus only. Since, many methods have been developed, to find a cheap method for the extraction of essential oil, and then protect the oil from evaporating before being implemented as a feed additive. Some foreign research on the use of orange peel essential oil shows prospective results. It is expected then, that the use of local orange peel essential oil will enable to replace the use of imported essential oil which is more expensive to the feed mills industry.

1 Introduction

Orange has been known as the third most consumed fruit in Indonesia after banana and mango. Citrus fruit is a type of fruit that comes from orange trees (Citrus spp.), which belong to the Rutaceae family. Oranges are one of the tropical fruits that are often locally planted and suitable for almost all areas. About 70-80% of the oranges developed in Indonesia are Siem oranges, and the rest are tangerines. In addition, Indonesia is the tenth highest orange producer in 2006, namely 2.6 million ton with production area of more than 72 thousand hectare and production per hectare of more than 30 ton [1]. According to our experience, each orange has 10-12% of peel wasted or the potency of more than 260 thousand tons of orange peel per year.

Oranges are characterized by thick, fleshy skin and are rich in vitamin C and other nutrients. Orange fruit has a sour or sweet taste, depending on the variety, and is often consumed directly or processed into various products such as juice, drinks, marmalade, jam, cakes and other foods. In Indonesia, there are at least 160 varieties of oranges cultivated. Oranges generally have peels that are easy to peel and come in several popular types, including sweet oranges (*Citrus sinensis*), tangerines (*Citrus reticulata*), grapefruit (*Citrus maxima*), and limes (*Citrus aurantiifolia*).

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In the era of banning the use of Antibiotic Growth Promoter (AGP) in poultry feed, essential oil has been one of the choices as AGP replacer. In fact, orange peel has been reported to also contain essential oil. Therefore, effort to produce alternative essential oil from waste of locally available orange peel is interesting. Because of waste, it should be very cheap and have no price. Processing of a low-cost orange peel usually will result about 1-3% of essential oil. This paper is summarized the potency and implementation of orange peel essential oil as feed additive for poultry.

2 The Potency of Locally Available Orange Peel

This paper will outline 4 different oranges which are locally available and its potential essential oil contained.

2.1 Grapefruit or Pamelo

Grapefruit (*Citrus maxima*) or pomelo is a species of tropical fruit plant that is widespread and cultivated in Southeast Asia and the East Indian Islands [2]. Grapefruit is characterized by leaves and fruit that are larger than other types of citrus and have a fragrant aroma when the flowers bloom. The skin of the pomelo is thick with a strong bond to the flesh of the fruit, the flesh has a crunchy texture with a sweet and sour taste and a bitter taste due to the presence of the naringin compound, the fruit grains are large with a white or red color.

Grapefruit contains many nutritional components, most of which are found in the peel, including alkaloids, flavonoids, lycopene, vitamin C and the most dominant are pectin and tannin [3]. La, et al. [4] in their research, n-hexane extract from grapefruit peel contains secondary metabolite compounds in the form of flavonoids, alkaloids, tannins, steroids and triterpenoids. In their research, Saputra, et al. [5] added that grapefruit peel essential oil has several compound components, namely limonene (94.96%), myrcen (2.48%), B-asaron (1.09%), germacen D (1.01%) and α pinene (0.46%). Li, et al. [6] in their research also reported the active ingredient content in grapefruit peel essential oil which is shown in table 1.

Table 1. Contents of essential oil in grapefruit peel

Component (%)	Saputra et al (2017)	Li et al (2022)
α-pinene	0.46	1.87
β-Laurene	-	5.93
D-Limonene	94.96	81.86
γ-pinene	-	0.17
Linalool	-	1.16

Saputra, et al. [5] in their research stated that grapefruit peel essential oil showed an inhibitory diameter of 17 mm against *Escherichia coli*. In addition, Li, et al. [6] also showed the inhibitory power of grapefruit peel essential oil against *Escherichia coli*, *Salmonella* and *Lactobacillus acidophilus* bacteria which can be seen in table 2.

Table 2. Diameter of inhibition zone (*in vitro*) due to application of grapefruit essential oil

Bacteria	Diameter of inhibition zone (mm)
Escherichia coli	10.67
Salmonella	12.33
Lactobacillus acidophilus	14.33

2.2 Sweet Orange (*Citrus sinensis*)

Sweet orange which have the scientific name *Citrus sinensis* (L) Osbeck is characterized by a shrub with a height of 3-10 meters, spiny branches ; short spike-shaped spines. Leaf stalks is 0.5 – 3.5 cm long. Leaf blades are ovate, elliptical or elongated, with blunt or bluntly tapered tips. The flower crown is white or yellowish white. Fruits of spherical shape, or depressed spherical shape are yellow, orange or green with yellow. The flesh is light yellow, yellow orange or reddish with bubbles that unite with each other [7]. Sweet orange in general (commonly orange) are sweet oranges with general characteristics, namely winged leaves, a high level of tightness of the skin and flesh of the fruit [8].

Li, et al. [6] in their research reported the inhibitory power of squeezed orange peel essential oil against the bacteria *Escherichia coli*, *Salmonella* and *Lactobacillus acidophilus* which can be seen in table 4.

Table 3. Diameter of inhibition zone (*in vitro*) due to application of sweet orange essential oil

Bacteria	Diameter of inhibition zone (mm)
Escherichia coli	11.33
Salmonella	11.33
Lactobacillus acidophilus	13.33

2.3 Tangerines (*Citrus reticulata* Blanco)

Tangerines are local oranges that are widely cultivated in Indonesia. Tangerines have the morphological characteristics of narrow or wide winged petioles, perfect flower types with the number of stamens four times the number of corollas, the skin of the fruit is easy to peel and the innerwebs are also easy to remove [8]. One of the popular varieties among business people and consumers of tangerines is the Batu 55 tangerine which was registered as a superior variety in 2006 (SK307/Kpts/SR.120/4/2006). The Batu 55 variety of tangerines has the characteristics of greenish yellow fruit skin, the skin surface is slightly rough and wavy, the skin is easy to peel, the fruit shape is round with the tip concave inward with a slightly flat base. The size of this fruit varies depending on the environmental conditions in which it grows, with the average fruit measuring 7.9 cm high and around 5.9 cm in diameter [7].

Tangerine (*Citrus reticulata* Blanco) is a plant that has antibacterial activity [9]. Tangerine peel contains a lot of vitamin C and various secondary metabolite compounds such as alkaloids, flavonoids, saponins, tannins, phenols as well as terpenoids and steroids [10]. Table 5 reported essential oil contents from different countries.

Table 4. Essential oil of sweet oranges from different countries

Country	Method extraction	Yield	Active substance 1	Active Substance 2	Active Substance 3	Author
Pakistan	Hydro-distillation	0.3 – 0.5 %	Limonene (69.9%)	Nootkatone	β-myrcene	Kamal et al. [11]
Bajumbura, the capital of Burundi	Cold-pressing	0.08 %	Limonene (84.8%)	γ-terpinena	Myrcene	Njoroge et al. [12]
State of Alagoas, Brazil	Hydro-distillation	2.04 %	Limonene (80.2%)	Myrcene	Linalool	Fouad et al. [13]
Tunisian	Hydro-distillation	4.62 %	Limonene (35.3%)	γ-terpinena	β-pinene	Hosni et al. [14]

Based on the table above, it can be seen that orange peel essential oil contains a major compound, namely limonene, followed by 3 other compounds whose levels are relatively high, namely terpinene, pinene and myrcene. The limonene compound is the compound most commonly found in all types of oranges and is reported to have anti-inflammatory, antibacterial, antiviral, antioxidant and other properties [7].

2.4 Santang Orange

Santang oranges (Clementine) are a cross between mandarin oranges (Citrus reticulata) and sweet oranges (Citrus sinensis) [15]. Santang oranges are smaller in size than oranges in general, usually consumed during celebrations of major holidays among Chinese Indonesians. The advantages of Santang oranges are that the flesh tastes predominantly sweet, the skin is orange, easy to peel, tends to be seedless and has a strong aroma.

The antibacterial activity of Santang orange peel essential oil can inhibit the fungus Candida albicans, Escherichia coli and Staphylococcus aureus bacteria with a concentration of 20 µl and the highest inhibitory power on Candida albicans, namely the inhibitory diameter of 20.67 ± 0.58 mm, followed by Staphylococcus aureus 14.67 ± 1.15 mm, and Escherichia coli 12.67 ± 0.58 mm [16].

In the research of [17] found that Salmonella typhimurium was determined to be the most resistant bacteria. 8 of the types of oranges, 3 of which did not show inhibition against Salmonella typhimurium, one of which was the Santang orange. The following are the inhibitory forces from several studies:

Table 5. Diameter of inhibition zone (*in vitro*) due to application of santang orange essential oil

Metode ekstraksi	*Escherichia coli*	*Salmonella* sp.	Author
Hydrodistillation	12.67	Not detected	Baygar [16]
Hydrodistillation	13.09	0	Boudries *et al.* [18]
Hydrodistillation	0	0	Bozkurt *et al.* [17]

Essential oils refer to secondary metabolite compounds that are famous for their antibacterial properties. Antibacterial is an inhibitory force for the development of bacteria and selective toxicity, where the material only weakens the pathogen but has no effect on the host [5]. The content of essential oil compounds can inhibit or kill bacterial growth which can be used as an antibacterial activity [5 ; 19]. Orange peel essential oil can prevent disease in livestock caused by pathogenic microbes and oxidative damage to the body due to its antibacterial, antioxidant and anti-inflammatory activities, as well as other biological activities [20].

3 Application of Orange Peel Essential Oil for Broiler

Several studies have been done with regard to response performance of broiler given orange essential oil as feed additive:

1. Improvement in broiler performance was reported after age of 5 or 6 weeks old given 200mg/kg feed [21],
2. Only increase feed intake without improvement body weight but significantly lower feed conversion ratio with the best result if given 3ml/kg feed [22],
3. Increased feed intake and body weight gain, also improved feed conversion with the best level 100mg/kg feed [23],
4. Increased feed intake and body weight gain, also improved feed conversion with the best level 150mg/kg feed [24].

In short, the use of orange peel essential oil as feed additive improves performances of broilers. It seems that orange peel essential oil might be used as AGP replacer in broiler and might be also other poultry.

4 Conclusion

It can be concluded that the local orange production has great potential to be processed as orange peel essential oil. The use of essential oil is a potential AGP replacer to be used as safer feed additive for poultry.

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