Inhibition of Meat Fat Autoxidation by Natural Essential Oils

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During storage, lipid oxidation deteriorates Speck meat fat quality. To inhibit oxidation, producers use synthetic antioxidants. However, this research will investigate essentials oils to preserve meat fat. Several officinal herbs and spices will be extracted by supercritical carbon dioxide extraction and tested for their capacity to inhibit meat fat oxidation. Soxhlet method will be used for quantifying the total fat content, and NMR to analyze the content of fatty acids. A Kinetic-based DPPH assay will be performed to understand mechanism of the antioxidant’s activity. Also, isothermal calorimetry and oximetry will be extensively used to measure the oxidizability of meat fats.

Inibizione dell'autossidazione dei grassi di carne da parte degli oli essenziali naturali

Durante lo stoccaggio, l'ossidazione lipidica deteriora la qualità del grasso della carne di Speck. Per inibire l'ossidazione, i produttori usano antiossidanti sintetici. Tuttavia, questa ricerca studierà gli oli essenziali per preservare il grasso della carne. Diverse erbe e spezie officinali saranno estratte mediante estrazione di anidride carbonica supercritica e testate per la loro capacità di inibire l'ossidazione del grasso della carne. Il metodo Soxhlet sarà utilizzato per quantificare il contenuto totale di grassi e NMR per analizzare il contenuto di acidi grassi. Verrà eseguito un test DPPH a base cinetica per comprendere il meccanismo dell'attività dell'antiossidante. Inoltre, la calorimetria isotermica e l'ossimetria saranno ampiamente utilizzate per misurare l'ossidabilità dei grassi della carne.

**1. State-of-the-Art**

**1.1 Auto­­-oxidation in meat products**

Meat and meat products are integral to the human diet and are an essential source of minerals, vitamins, and many other essential nutrients (Zhang, Xiao *et al*. 2010). Meat fat is the main target of oxidation, as it contains high levels of unsaturated fatty acids. The oxidation of meat fat can be accelerated by several factors such as heat, light, and oxygen (Chen, Zhou *et al*. 2015). Adding natural antioxidants and essential oils to meat can help delay the oxidation process and increase the shelf life of meat products.

According to a study, inclusion of BHA and BHT increased the oxidative stability of speck (Neethling, *Suman et al.* 2016), but these synthetic antioxidants are not very beneficial for health and these days trend is more towards using antioxidants driven from natural sources like plants extract herbs and spices.

**1.2 Role of essential oils in meat fat stability:**

Essential oils are also being researched for their potential to act as natural antioxidants in meat products. According to studies, essential oils can effectively stop meat oxidation and extend its shelf life (Rojas and Brewer *et al*. 2007). To get the highest antioxidant activity, the ideal quantities and combinations of essential oils must be determined.

**1.3 Experimental methodologies to analyze meat oxidation and stability:**

Fat extraction using soxhlet method offers a repeatable and precise determination. NMR technique will be used due to its excellent sensitivity and selectivity for both saturated and unsaturated fatty acids (Marcone, Wang *et al.* 2013). To determine whether the antioxidant mechanism of speck fat is based on hydrogen atom transfer or electron transfer, kinetic-based DPPH test will be carried out in a variety of solvent systems. Oximetry will be used to monitors the oxygen intake or consumption during chemical processes, whereas isothermal calorimetry measures the heat produced or absorbed during chemical reactions (Klettenhammer, Ferrentino *et al*. 2023). A thorough knowledge of the antioxidant capabilities of essential oils can be obtained by combining these approaches. This information will aid in the creation of novel techniques for maintaining and improving the quality of meat products.

**2. PhD Thesis Objectives and Milestones**

The research objectives of this PhD project can be achieved through the following activities and working plan as shown in the Gantt diagram given in Table 1:

A1) **Literature review and analysis of speck meat fat oxidation:** Literature review and analyze the oxidizability of speck meat fat from South Tyrol and find the role of natural essential oils in the inhibition of speck meat fat autoxidation.

A2) **Optimization of methods:** Optimization of methods for extraction of herbs and spices using supercritical carbon dioxide extraction and analysis of meat fat oxidation using isothermal calorimetry.

A3) **Antioxidant capacity of essentials oils:** To investigate the antioxidant capacity and optimal concentration of different essential oils required to prevent oxidation of speck meat fat during storage without affecting its taste.

A4) **Comparative analysis of natural and synthetic antioxidants:** The difference between the efficacy of essential oils and synthetic antioxidants in inhibiting speck meat fat oxidation will eventually promote the use of natural essential oils to be used in preserving speck meat.

A5) **Finalization of dissertation and PhD Defense:** Finalization of the PhD thesis, scientific papers and poster communications.

***Table 1*** *Gantt diagram for this PhD thesis project.*

|  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- | --- |
| Activity Months | **1** | **2** | **3** | **4** | **5** | **6** | **7** | **8** | **9** | **10** | **11** | **12** | **13** | **14** | **15** | **16** | **17** | **18** | **19** | **20** | **21** | **22** | **23** | **24** |
| A1) | ***Literature review and analysis***  |   |   |   |  |  |  |  |   |   |  |  |  |  |   |  |  |  |  |   |   |  |  |  |  |
|  | 1) Literature Review |   |  |   |  |  |  |  |   |   |  |  |  |  |   |  |  |  |  |   |   |  |  |  |  |
|  | 2) Oxidation analysis using TAM |   |  |   |  |  |  |  |   |   |  |  |  |  |   |  |  |  |  |   |   |  |  |  |  |
| A2) | ***Optimization of methods***  |   |   |   |  |  |  |  |   |   |  |  |  |  |   |   |   |  |   |   |   |  |  |  |  |
|  | 1) Supercritical carbon dioxide extraction method  |   |   |   |  |  |  |  |   |   |  |  |  |  |   |   |  |  |  |   |   |  |  |  |  |
|  | 2) Isothermal Calorimetry method |   |  |   |  |  |  |  |   |   |  |  |  |  |   |  |   |  |   |   |   |  |  |  |  |
| A3) | ***Antioxidant capacity of essential oils***  |   |  |   |   |   |   |  |   |   |   |   |   |  |   |  |  |  |  |   |   |   |   |   |  |
| A4) | ***Comparative analysis of natural and synthetic antioxidants*** |   |  |   |  |  |   |   |   |   |  |  |   |   |   |  |  |  |  |   |   |  |  |   |   |
| A5) | ***Finalization of dissertation and Paper Preparation*** |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |   |  |   |   |   |   |   |   |   |

**3. Selected References**

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