# Optimized Nanoemulsion from Pumpkin By-Product Phenolic Extracts: Physicochemical and Biological Characterization for Enhanced Functional Food Applications

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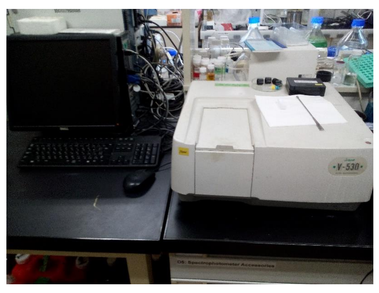
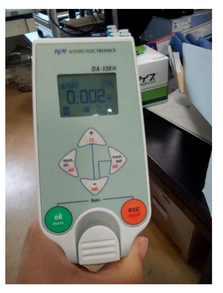
**Background:** Pumpkin by-products are **rich in phenolic compounds** known for their significant antioxidant and antibacterial properties. Utilizing these by-products for **value-added products** can contribute to sustainable agricultural practices and waste reduction. **Nanoemulsions**, due to their small droplet size and high stability, are promising **carriers for bioactive compounds**, enhancing their solubility, stability, and bioavailability. This study aims to harness the **benefits of pumpkin by-product phenolic** extracts by formulating an optimized nanoemulsion, characterized for its physicochemical properties and biological activities. By employing the **Box Behnken design** for statistical validation, the study seeks to optimize the formulation parameters and evaluate the potential health benefits and applications of the resulting nanoemulsion..

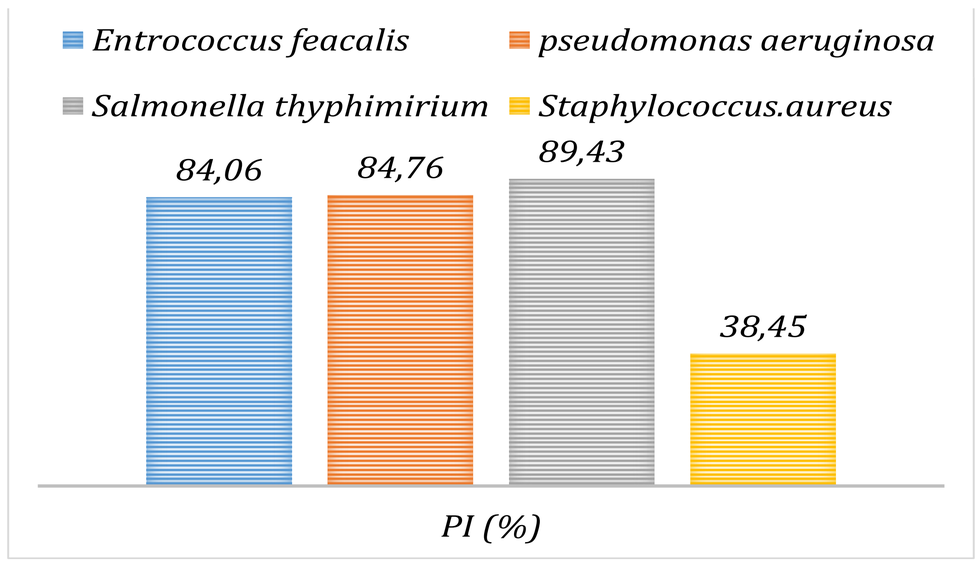





**Materials/Methods:** The evaluation of the encapsulated refined extract encompassed a comprehensive methodology encompassing **physicochemical, antioxidant, and antimicrobial analyses**. Physicochemical characterization involved viscosity measurement in mPa/s and pH determination. Turbidity was quantified and color attributes (L, a, b) were recorded. Additionally, antioxidant assessment, the ABTS and DPPH assays measured radical-scavenging potential, while total antioxidant activity and polyphenol content were quantified colorimetrically in mgGAE/gDR. Simultaneously, the antimicrobial profile was investigated using growth Inhibition Percent (PI) against bacterial strains. PI values represented susceptibility as percentages. For all tests, 3 to 6 replicates were used.

| | Results | Units |
|---|---|---|
| **Viscosity** | 17± 0.01 | mPa/s |
| **pH** | 4.2± 0.23 | - |
| **Color : L** | 102.4 | - |
| **Color : a** | 3.5 | - |
| **Color : b** | 7.8 | - |
| **Turbidity** | 0.412± 0.05 | - |
| ***Whitening index*** | 102.8 | - |




**Results:** Considering the physicochemical parameters, the viscosity of the encapsulated extract is 17 mPa/s with a negligible variation of ± 0.01. The pH of the extract is 4.2, showing a slight fluctuation of ± 0.23. Color measurements include L (lightness) at 102.4, a (redness) at 3.5, and b (yellowness) at 7.8. Turbidity is 0.412. The units for viscosity are millipascal-seconds (mPa/s), pH, color values and turbidity are unitless. The encapsulated refined extract's biological characterization reveal its **important antioxidant potential** and composition. The ABTS level of 53.9% demonstrates significant radical scavenging ability. With a total antioxidant activity of 4.2 mgGAE/gDR, the **extract exhibits noteworthy capacity to counteract oxidants**, which can have positive health implications. The total polyphenol content of 37.2 mg GAE/gDR emphasizes the **abundance of encapsulated antioxidative** compounds. Additionally, the encapsulated extract's antiradical activity of 44.2% underscores its efficacy in mitigating radical-induced damage. Despite minor fluctuations in some measurements, the collective findings strongly suggest that **the encapsulated extract possesses robust antioxidant attributes**. Switching to antibacterial potency, the last table provides the growth Inhibition Percent (PI) of encapsulated refined extract against various bacterial strains. *Enterococcus faecalis* exhibits a PI of 84%, demonstrating its sensitivity to the tested agent. *Pseudomonas aeruginosa* also shows **notable sensitivity**, with a PI of 85%. *Salmonella typhimurium* records the highest sensitivity at 89%, while *s*displays a lower sensitivity, registering a PI of 38%.

| | results | Units |
|---|---|---|
| **ABTS** | 53.89± 0.07 | % |
| **Total antioxidant activity** | 4.19± 0.06 | mgGAE/gDR |
| **Total polyphenol content** | 37.2± 1.52 | mg GAE/g DR |
| **Antiradical activity** | 44.2± 2.04 | % |

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