By-products from agri-food industrial sector: resource or waste? An eco-friendly utilization to preserve the food’s quality

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Coffee silverskin, coffee roasting by-product, was characterised for its antioxidant properties. Different extraction parameters were tested to recover bioactive compounds. The best selected extract was used in the formulation of gummy candies at different concentrations and qualitative analysis were carried out up to 120 days of storage at 25°C. Higher quality, in terms of antioxidant activity, sensory and textural characteristics, was observed in candies formulated with 1% of coffee silverskin extract. This valorisation of coffee by-product could satisfy consumer’s demand for the use of eco-friendly resource to produce foods and to preserve their quality.

Sottoprodotti del settore agroalimentare: rifiuti o risorse? Un’utilizzazione eco-sostenibile per preservare la qualità degli alimenti

Coffee silverskin, sottoprodotto della torrefazione del caffè, è stato caratterizzato per le sue proprietà antiossidanti. Sono stati testati differenti parametri di estrazione al fine di recuperare composti bioattivi. Il miglior estratto è stato utilizzato, a differenti concentrazioni, per la formulazione di caramelle gommose sulle quali sono state condotte analisi qualitative per 120 giorni di conservazione a 25 °C. Le caramelle con 1% di estratto hanno presentato una spiccata qualità per attività antiossidante, caratteristiche sensoriali e strutturali. Questa valorizzazione del sottoprodotto del caffè potrebbe soddisfare la domanda dei consumatori riguardo l’utilizzazione di risorse eco-sostenibili per produrre alimenti e preservarne la qualità.

**Key words**: Agri-food waste; coffee by-products; bioactive compounds, fortified food, gummy candies.

# **1. Introduction**

In accordance with the PhD thesis project, this poster reports the main results of the following activities:

(A1) Extraction of bioactive compounds from coffee silverskin and characterization of obtained extracts;

(A2) Formulation of gummy candies with selected coffee silverskin extract;

(A3) Determination of physical, chemical, sensory and microbiological characteristics of gummy candies over time.

# **2. Materials and Methods**

Conventional (maceration, ME) and innovative (ultrasound assisted, UAE) techniques as well as variables that affect the extraction process (method, time, temperature and nature of the solvent) were tested in order to identify the best conditions to recover bioactive compounds from coffee silverskin (CS). All the extractions were tested by mixing 2 g of CS powder (moisture < 10%) with 20 mL of food grade solvents (H2O and H2O/ EtOH 90/10, 80/20, 70/30, 50/50 and 20/80) at different temperatures (40 °C, 50 °C, 60 °C and 70 °C) and times (30, 60, 90 and 120 minutes). Frequency of 59 kHz was used for UAE. All obtained extracts were evaluated for total phenolics content (TPC), antioxidant activity (DPPH and ABTS assays) (Costa *et al.*, 2014) and microbial count. Subsequently, the best extract (CSE) was selected for bioactive content and tested on chemical, physical (Cedeño-Pinos *et al*., 2020), microbiological (Teixeira-Lemos *et al*., 2021) and sensory characteristics of the fruit gummy candies. Control Candies (CTR) were formulated with 31% of sucrose, 28% of glucose syrup, 22% of apricot juice, 8% of pork gelatine, 1% of citric acid and 10% of water. The fortified gummy candies were formulated partially substituting water with 1% (CS1), 2% (CS2) and 4% (CS3) of CS extract. The candies were stored for 120 days at 25 °C. Statistical analysis was performed by one-way analysis of variance and Tukey’s comparison test.

# **3. Results and Discussion**

## **3.1 Characterization coffee silverskin extracts (CSE)**

The best extract was obtained by ME at 60 ºC for 60 minutes using the hydroalcoholic mixture EtOH 30%, which showed a TPC of 1955 μg GAE mL-1, 10.74 and 3.67 μmol Trolox mL-1 respectively for ABTS and DPPH assay. Temperatures higher or lower 60 ºC, solvents with ethanol above 50% and below 20% and times higher or lower 60 minutes significantly worsen the efficiency of extraction due to lower diffusion rate and solubility of compounds in solvents. Also, lower bioactive yield (about -75%) was observed in all samples extracted by UAE. Previous studies indicated that use of frequencies > 40 kHz during UAE can favour the occurrence of inertial cavitation phenomena leading to the formation of free radicals and a consequent decrease in substances subject to oxidation (Masuda *et al.*, 2015). Extraction tests revealed that solvents play a key role in the recovery of bioactive compounds. Among the various tested solvents, only the 20, 30 and 50% hydroalcoholic mixtures favoured the recovery of compounds with a more marked antioxidant activity. The lower qualitative yield obtained with the other tested solvents could be caused by the presence in CS of different compounds with different chemical structure and polarity whose recovery is strongly influenced by the affinity with the composition of the mixture (Murthy *et al.*, 2012).

## **3.2 Physical-chemical and sensory characteristic of gummy candies**

The obtained results (Table 1) suggested that the TPC and antioxidant activity were dose-dependent because a significant increase was found after the addition with increasing percentages of CSE. In fact, after the formulation, CS1, CS2 and CS3 showed TPC (273-317 μg GAE g-1) and antioxidant activity (39-46 μmol Trolox g-1)significantly higher than CTR (265 μg GAE g-1 and 24.43 μmol Trolox g-1, respectively) and this trend was generally maintained during the storage. The observed results of antioxidant activity despite the evident reduction of TPC during time (about 50%) reveal the possible presence of other chemical compounds with radical scavenging properties, such as melanoidins generated during the coffee roasting process, as also confirmed by previous studies (Tores de la Cruz *et al.*, 2019). The addition of CSE has also affected the variation of other physical and chemical parameters (water activity, solid soluble content, moisture, pH). However, previous studies have reported that maintaining aw between 0.55 and 0.75 and moisture between 8% and 22% allow to preserve the quality characteristics of the gummy candies over time (Ergun *et al*., 2010). Our observed results denoted a conformity in these ranges. About other physical parameters, increasing concentration of CSE has significantly affected the colour of the candies, resulting in a gradual change in colour from yellow-orange to orange-brown (data not shown) and the mechanical properties, with gradual increase of gumminess. Nevertheless, the results obtained from the sensory analysis indicated that the proposed products were appreciated for all the sensory attributes tested (appearance, olfactory, taste and texture sensations). Specifically, CS1 obtained a higher score (7.7) than the other ones (6.2-7.2) correlated with a greater perception of the fruity. Finally, a microbial quality was confirmed by the absence of moulds and yeasts contamination in all tested enriched gummy candies. The results up to 120 days of storage revealed the higher quality in CS1 gummy candies not only for their bioactive content and antioxidant activity but also for their sensory and structural characteristics. These findings suggested that coffee silverskin can be used as ingredient for preserving the confectionery product quality and increasing their functional properties.

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| **Parameters** | **Days** | **CTRL** | **CS 1** | **CS 2** | **CS 3** | **Sign** |
| TPC(μg GAE g-1) | 0 | 265.1 c | 272.7 bc | 282.3 b | 317.1 a | \*\* |
| 120 | 131.4 bc | 161.1 a | 128.0 c | 147.9 ab | \*\* |
| ABTS assay(μmol Trolox g-1) | 0 | 24.43 c | 38.65 b | 42.81 a | 45.75 a | \*\* |
| 120 | 15.06 b | 31.49 a  | 30.25 a | 28.20 a | \*\* |
| Moisture  | 0 | 19.87 a | 19.97 a | 18.5 b | 18.3 b | \*\* |
| (g/100 g) | 120 | 17.8 a | 16.8 b | 16.5 b | 13.5 c | \*\* |
| aw | 0 | 0.65 b | 0.66 a | 0.65 c | 0.60 d | \*\*  |
| 120 | 0.58 c | 0.55 d | 0.64 a | 0.60 b | \*\* |
| pH | 0 | 3.86 b | 3.85 b | 3.93 a | 3.94 a | \*\* |
| 120 | 3.90 c | 3.90 c | 4.00 b | 3.99 a | \*\* |
| Gumminess (N) | 0 | 9.44 c | 9.66 c | 12.88 a | 11.22 b | \*\* |
| 120 | 61.37 b | 63.58 b | 68.20 ab | 75.83 a | \*\* |
| Total acceptability | 0 | 7.2b | 7.7a  | 7.2b | 6.8 c |  \*\* |
| 120 | 6.5b | 7.3a  | 6.3b | 6.0 c |  \*\* |

**Table 1** *Qualitative parameters of fruit gummy candy samples during the storage.*

# **4. References**

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