Analysis and characterization of Sicilian cereals landraces to destined at malting and brewing industry

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The first activities of the dissertation project involved the study of the malting aptitude of the old Sicilian landrace of Maiorca wheat and four varieties of two-rows barley that were grown in Sicily, these were respectively: Fortuna, Fandaga, Concerto and Planet. The wheat and barley varieties were malted in a pilot micro-malting plant using two malting programs. Several quality parameters were determined on malts such as: germination energy, thousand kernel weight, moisture, extract, total and soluble protein content, Kolbach Index, total starch, α- and β-amylase, diastatic power, fermentability and saccharification time.

Analisi e caratterizzazione delle varietà autoctone siciliane di grano e orzo da indirizzare all’industria del malto e della birra

Le prime attività del progetto di tesi di dottorato hanno riguardato lo studio dell'attitudine alla maltazione della varietà di grano antico siciliano Maiorca e di quattro varietà di orzo distico coltivate in Sicilia, questi ultimi erano rispettivamente: Fortuna, Fandaga, Concerto e Planet. Le varietà di frumento e orzo sono state maltate in un impianto di maltazione pilota utilizzando due programmi di maltazione. Nei malti ottenuti sono stati determinati diversi parametri qualitativi quali: energia germinativa, peso di mille semi, umidità, estratto, contenuto proteico totale e solubile, Indice di Kolbach, amido totale, α- e β-amilasi, potere diastatico, fermentabilità e tempo di saccarificazione.

**Key words**: malting process, wheat malt, barley malt, brewing process, cereals old landraces, Maiorca wheat malt.

# **1. Introduction**

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

(A1) Preliminary evaluation of un-malted wheat and barley landraces.

(A2) Pilot-scale malting trials performed in an automatic micro-malting system.

(A3) Physicochemical evaluation of malts and wort through the analysis of the most important quality index for malters and brewers as the content of extract, total starch, total protein content, soluble protein content, Kolbach Index, diastatic power, α-amylase and β-amylase content.

# **2. Materials and Methods**

The malting trials were performed in triplicate in an automatic micro-malting system in SAAF Department of University of Palermo (Italy). The samples of wheat and barleys were cleaned to remove the glumes and husks, or, if present, external contaminants. Concerning Maiorca, the malting processes were carried out according to the conditions proposed by Alfeo et al. 2018a. For each basket, 500 g of grains were placed in steeped in water at 15 °C for 5 h, followed by 8 h of air-rest, and further 4 h in water, reaching steeping-out moisture of 41 %. The germination occurred after 120 h at 15 °C and 95 % of relative humidity, then the samples were dried and kilned for 34,5 h as follow: 3 h at 55 °C, 12 h at 60 °C, 10 h at 65 °C, 5 h at 70 °C, and 4,5 h at 75 °C. The barley samples were malted according to the following the malting conditions: 500 g of grains were placed in steeped in water at 15 °C for 10 h, followed by 12 h of air-rest, and further 6 h in water, reaching steeping-out moisture of 42 %. The germination occurred after 90 h at 15 °C and 95 % of relative humidity, then the samples were dried and kilned for 24 h as follow: 3 h at 55 °C, 9 h at 60 °C, 6 h at 65 °C, 2 h at 75 °C, and 4h at 85 °C. The analyses of malt and wort were performed in triplicate according to methods of Analytica European Brewery Convention (EBC). The Megazyme assay kits (Megazyme International, Ireland) were used for total starch (db%), α- and β- amylases (respectively T-STARCH following the AOAC Method 996.11 and K-MALTA).

# **3. Results and Discussion**

The malt samples were analyzed, and the main parameters studied were summarized in Table 1. The choice of a cereal for malting considers the parameters that ensure the production of a high-quality malt, among them: thousand kernel weight (TKW), germination energy and protein content. TKW is a valuable parameter to maltsters and millers that is correlated with larger kernel size, homogeneous milling and proportionally higher endosperm (Armstrong et al., 2002). In the cereals studied, the TKW was between 31.5 g and 39.7 g; the lowest value was for Maiorca wheat while among barley the lowest was for Concerto barley and the highest for Fortuna barley. Germination energy was evaluated to understand the health status of the seeds and their sensitivity to water (Briggs, 1998; Rani & Bhardwaj, 2021; Domin et al., 2019). The varieties studied showed high germinability values, all exceeding 97%. Regarding protein content, Maiorca malt showed a higher protein content than barley varieties, specifically 12.34 %db. The protein content in the barleys varied between 9.1 and 10.2%db. The protein content of the studied samples was generally in line with the values found in the literature recommended for wheat malt and barley malt (Faltermaier et al., 2014). Concerning malt quality parameters, Maiorca wheat malt showed values comparable to studies conducted previously by Alfeo et al, 2021 on Sicilian wheat landraces. The malting programs tested on wheat and barleys were suitable to ensure a good degree of grain modification and high malt quality that showed high values for: extract, fermentability, Kolbach Index, total starch, alpha and beta amylase and diastatic power. Extract on dry basis were for all samples above 82%, the highest value was for Maoirca malt in which it was around 84%db with a fermentability of 81.9%, thus showing a high amylolytic activity of amylase enzymes. Maiorca malt showed a diastatic power of 374.59 °WK positively correlated with β-amylase content which was 39.03 (BU g-1 db). The α-amylases that typically develop during malting starting from the second day was 200.95 (CU g-1 db). The barley samples studied also showed extract values above 82% with fermentability between 80 and 81.7%. The diastatic power of the barley malts was between 287 and 322 °WK, it showed an adequate enzyme content developed by the malting process. Concerning enzymes content, the content of α-amylase in barley malt samples was in range between 210 and 236 (CU g-1 db), respectively for Concerto and Fandaga. Compared to Maiorca malt, lower values were found for β-amylases. The β-amylase content in barley malts was between 13.55 and 15.75 (BU g-1 db) respectively for Fandaga and Planet. In all samples, the adequate grain modification was highlighted by the Kolbach Index, which had optimum values between 34.5% and 38.29% for Concerto barley variety and Maiorca malt, respectively. In conclusion, it was seen that all the varieties studied showed a good response to the malting parameters used; all varieties have the parameters evaluated by maltsters and brewers within the optimal ranges resulting good for brewing purpose.

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| **Parameter** | **Maiorca** | **Fortuna** | **Fandaga** | **Concerto** | **Planet** |
| Thousand Corn Weight (g) | 31.50±0.10 | 39.70±0.36 | 37±0.12 | 33.50±0.18 | 37±0.57 |
| Germination energy (%) | 97.50±0.01 | 98±0.08 | 97.5±0.04 | 97±0.09 | 97.50±0.04 |
| Moinsture (% ww-1) | 5.29±0.33 | 2.02±0.04 | 2.47±0.05 | 2.25±0.04 | 2.06±0.04 |
| Extract (%db) | 84.65±0.53 | 82.32±1.64 | 83.69±1.67 | 82.32±1.64 | 82.41±1.64 |
| pH 20°C | 6.13±0.04 | 5.98±0.07 | 5.78±0.11 | 5.38 ±0.10 | 5.78±0.23 |
| Saccarification time (min) | <10 | < 10 | < 10 | < 10 | < 10 |
| Colour (EBC unit) | 4.87±0.11 | 3.70±0.18 | 3.78±0.26 | 3.27±0.08 | 5.69±0.10 |
| Fermentability (%) | 81.90±0.15 | 80.70±0.24 | 80.30±0.68 | 81.70±0.38 | 81.20±0.08 |
| Proteins (%db) | 12.34±0.44 | 9.10±0.17 | 9.2±0.18 | 10.2±0.20 | 10.10±0.19 |
| Sol.Proteins (%db) | 4.71±0.14 | 3.51±0.07 | 3.46±0.07 | 3.52±0.07 | 3.59±0.06 |
| Kolbach Index (%) | 38.29±2.54 | 38.12±0.70 | 37.39±0.70 | 34.50±0.69 | 35.52±0.69 |
| Starch (%db) | 62.60±0.88 | 56.82±2.05 | 52.62±1.05 | 53.27±1.45 | 55.38±1.08 |
| α-amylase (BU g-1 db) | 200.95±1.22 | 223.06±18.73 | 236.98±1.63 | 210.16±1.80 | 214.27±0.16 |
| β-amylase (BU g-1 db) | 39.03±0.08 | 14.91±4.05 | 13.55±0.12 | 13.76±0.92 | 15.75±0.73 |
| Diastatic power (°WK) | 375.59±2.53 | 290.25±4.19 | 322.09±5.70 | 287.13±4.63 | 304.13±4.48 |

***Table 1*** *Malts quality parameters.*

# **4. References**

Alfeo V., De Francesco G., Sileoni V., Blangiforti S., Palmeri R., Aerts G., ... & Todaro A. (2021). Physicochemical properties, sugar profile, and non-starch polysaccharides characterization of old wheat malt landraces. Journal of Food Composition and Analysis, 102, 103997.

Alfeo V., Jaskula-Goiris B., Venora G., Schimmenti E., Aerts G., & Todaro A. (2018). Screening of durum wheat landraces (Triticum turgidum subsp. durum) for the malting suitability. Journal of Cereal Science, 83, 101-109.

Analytica‐EBC. (2008). European Brewery Convention: Analytica‐EBC.

Armstrong B., Weiss M., Grieg R., & Aldred G. (2002). Using digital image analysis to accurately determine the thousand kernel weight of randomly distributed barley, malt and wheat samples. Cereal proceedings, 115-118.

Briggs D. E. (1998). Malts and malting. Springer Science & Business Media.

Domin M., Kluza F., Góral D., Nazarewicz S., Kozłowicz K., Szmigielski M., & Ślaska-Grzywna B. (2019). Germination energy and capacity of maize seeds following low-temperature short storage. Sustainability, 12(1), 46.

Faltermaier A., Waters D., Becker T., Arendt E., & Gastl M. (2014). Common wheat (Triticum aestivum L.) and its use as a brewing cereal–a review. Journal of the Institute of Brewing, 120(1), 1-15.

Rani H., & Bhardwaj R. D. (2021). Quality attributes for barley malt:“The backbone of beer”. Journal of Food Science, 86(8), 3322-3340.