Journal of Cereal Science 63 (2015) 49–56

Contents lists available at ScienceDirect

Journal of Cereal Science

journal homepage: www.elsevier.com/locate/jcs

Impact of different beer yeasts on wheat dough and bread quality parameters

Mareile Heitmann, Emanuele Zannini, Elke K. Arendt*

School of Food and Nutritional Sciences, University College Cork, Ireland

ARTICLE INFO

Article history:
Received 10 November 2014
Received in revised form
17 February 2015
Accepted 26 February 2015
Available online 28 March 2015

Keywords:
Saccharomyces cerevisiae
Wheat bread
Beer yeast
Baker's yeast

ABSTRACT

In order to investigate the impact of different yeast strains from the species *Saccharomyces cerevisiae* on the dough and bread quality parameters, wheat flour was fermented using different beer yeasts. The results show that beer yeast strains could be included in the baking process since *S. cerevisiae* T-58 and *S. cerevisiae* s-23 provided adequate gas production and dough formation with superior structural properties like extensibility and stickiness to *S. cerevisiae* baker's yeast. The resulting breads show the highest specific volume with the highest slice area and the highest number of cells and the lowest hardness over time. The different yeasts had also an impact on the crust colour due to their abilities to ferment different sugars and on shelf life due to the production of a range of different metabolic by-products. According to this study it was possible to produce higher quality bread by using yeast coming from the brewing industry, instead of bread containing standard baker's yeast.

1. Introduction

One of the oldest biochemical processes in the whole world is the preparation of bread and beer through yeast fermentation (Linko et al., 1997). Surprisingly, the fermentation process and its correlation between product quality parameters are still not completely understood (Mondal and Datta, 2008) and next to brewer's and wine making yeast, less attention was demanded to baker's yeast (Dequin, 2001). Most of the baking processes are linked to a fermentation step mainly dominated by the yeast strain *Saccharomyces cerevisiae*, regularly mentioned as baker's yeast (Fleet, 2007). A baker's yeast with excellent processing characteristics should ensure an uniform dough leavening, be a good flavour producer and tolerate a wide range of temperatures, pH, as well as sugar and salt concentration (Linko et al., 1997). Therefore, fermentation as a step in bread making, has a large impact on the improvement of shelf life, texture, taste and flavour of the final product (Fleet, 2007). Yeasts can also have an impact on the production, quality, sensory and safety of each bakery product (Fleet, 2007). The main ingredients for baking are flour and water, which influences the overall texture and the crumb, as well as salt which strengthens the gluten network and yeast as a leavening agent for a good dough development. Additionally, sugar (for starting the fermentation), fat (for a better machinability), sodium stearoyl lactylate (emulsifier) and ascorbic acid (for strengthen the dough) are added. Freshly baked bread is generally characterised by a crispy crust, soft crumb, a pleasant mouth feel and an intensive flavour (Giannou et al., 2003). The review of published literature showed that most of the studies detailed experimental aspects (temperature, volume expansion and moisture content), analytical aspects (energy requirement and rheological properties) (Ktenioudaki et al., 2010; Salvador et al., 2006), along with the development of new baking technologies (new materials and ingredients as well as un-proofed, cooled or frozen doughs) (Decock and Cappelle, 2005) and new techniques (different dough mixing procedures) (Giannou et al., 2003) in the bread making process (Mondal and Datta, 2008). Besides the baking process, the research effort has focused almost exclusively on yeast activity during the dough fermentation and the aroma profile developed in the resulting bread (Connelly and McIntier, 2008). However, limited effort has been put in the investigation of the technological performance of *S. cerevisiae* in baking applications by underestimating

Abbreviations: H_m, maximum height; HPLC, High performance liquid chromatography; L*, Lightness; RH, relative humidity; RID, Reflective index detector; *S., Saccharomyces*; SSL, Sodium steaoryl lactate; T1, the time the dough needs to achieve Hm; V_{Lost}, the carbon dioxide volume released by the dough; V_{Ret}, carbon dioxide volume kept in the dough; V_{Total}, total carbon dioxide volume reached.

* Corresponding author. School of Food and Nutritional Sciences, University College Cork, Western Road, Cork, Ireland. Tel.: +353 21 4902064; fax: +353 21 4270213.
E-mail address: e.arendt@ucc.ie (E.K. Arendt).

http://dx.doi.org/10.1016/j.jcs.2015.02.008
0733-5210/

the key roles that yeast strains play in bread systems. Therefore, in the present study, systematic baking trials and dough analysis were carried out, based on a standard recipe and procedure with 4 different beer yeasts in comparison to baker's yeast used as a control. Originally, one single strain of yeast was used for both processes, brewing and baking. Long ago in Egypt and the Middle East, both processes, brewing and baking, were closely linked. That remained until the nineteenth century where yeast left over from the breweries was used for bread making. Nowadays, genetically improved microbial cultures are available for commercial use to better suit the need of the operator (Amendola and Rees, 2003). Beer yeast strains feature optimized metabolism suitable for beer making in terms of flavour compounds and alcohol production differently to baker's yeast which concentrates on a fast fermentation and uniform dough leavening due to carbon dioxide production. Connecting the results of brewer's yeast with baker's yeast could be highly profitable, to better understand the fundamental fermentation process. This study could open an unexplored scenario on yeast application through a tailored modulation of dough characteristics, bread quality parameters and sensory profiles and help to develop a new generation of yeast strains with enhanced technological characteristics.

2. Experimental

2.1. Materials

The suppliers of the ingredients used were Unifoods ingredients for bakers' flour (12.7% moisture, 0.8% ash); sugar from Siucra, Ireland; salt from Glacia British Salt Limited, UK; Sodium stearoyl lactylate (SSL) from Danisco, Denmark; commercially available sunflower oil and ascorbic acid from Storefast Solutions, UK. Instant active dry baker's yeast was obtained from Puratos, Belgium; Dry yeast s-23 (Lager yeast), T-58, us-05 (Ale yeast) and wb-06 (wheat beer yeast) were supplied by Fermentis Division of S. I. Lesaffre, France. All the used yeasts belonged to the species *S. cerevisiae.*

2.2. Cell count

To determine the cell viability (cfu/g) of the yeast powders, 1 g freeze dried yeast was suspended in 10 mL distilled water. From this stock solution, serial dilutions were prepared with ringer solution and spread on malt extract agar (Merck, Germany) plates and incubated aerobically for 2 days at 25 °C. Plates with 30–300 colonies were selected for yeast cell counts.

2.3. Bread-making

Wheat breads were prepared using 2% salt, 1.5% sugar, 3% fat, 0.5% SSL, 0.1% ascorbic acid and 2% yeast, based on flour. The amount of yeast was adapted according to the cell count in order to standardize the inoculum size. Yeast was dissolved in water (25 °C) and activated for 10 min. The yeast/water mixture was added to the premixed dry ingredients and the fat. Mixing was performed for 1 min at speed 1 with a spiral mixer Pietroberto SF (Food Equipment Service, Northern Ireland). The dough was scraped down from the bowl, and a further mixing step at speed 2 was carried out for 7 min. Bulk fermentation for the wheat dough was performed for 15 min in a proofer (KOMA SunRiser, Roermond, The Netherlands) set at 30 °C with a relative humidity (RH) of 85%. The doughs were scaled to 400 g into 9 baking tins of 15 × 9.5 × 9.7 cm and placed again in the proofer for 60 min (30 °C, 85% RH). Baking was carried out for 30 min at 230 °C top and bottom temperature in a deck oven (MIWE condo, Arnstein, Germany), previously steamed with 0.3 L of water and subsequently with 0.7 L of water. After baking, the bread loaves were directly removed from the tins and cooled down at room temperature for 120 min. Finally the loaves were analysed and stored in plastic bags at room temperature.

2.4. Rheofermentometer analysis

The rheofermentometer (Chopin, France) measures the dough development according to the production and retention of carbon dioxide during fermentation. Wheat dough was fermented with four different beer yeasts to determine its gaseous release and dough development characteristics. For the measurement, three hundred grams of dough were prepared as described for bread making. The experimental dough was placed into the fermentation chamber and fermented at 30 °C over 180 min. A cylindrical weight of 1500 g was attached to the fermentation chamber. The fermentation performance of the dough is expressed using several parameters such as; the dough development curve (maximum height of the dough sample - Hm), the time the dough needs to achieve this height (T1) and the dough volume reached through carbon dioxide production throughout the whole fermentation process (V_{Total}).

2.5. Extensibility

Dough extensibility and resistance to extension was measured by a TA-XT2i texture analyser (Stable Micro Systems, Surrey, UK) equipped with a Kieffer Dough and Gluten Extensibility Rig with a 5 kg load cell (Verheyen et al., 2014). Dough was mixed according to the bread making procedure. All doughs were measured 5 times after 60 min of proofing at 30 °C and RH of 85%. The measurement was performed under the following settings: pre-test speed of 2 mm/s, test speed of 3.3 mm/s, post-test speed of 10.0 mm/s and a force of 5 g. The following values calculated by the TA-XT2i software were chosen to describe the behaviour of the dough: extensibility (distance to break [mm]) and resistance to extension (maximum force [N]).

2.6. Dough stickiness

Dough stickiness was measured using a TA-XT2i texture analyser (Stable Micro Systems, Surrey, UK) equipped with a 1″ spherical probe (plastic 13097) and a 5 kg load cell. Dough was prepared according to the bread making procedure and the measurement was done before and after 1 h proofing. The settings used for this measurement were: pre-test speed of 0.4 mm/s, test speed of 0.5 mm/s, post-test speed of 10.0 mm/s, return distance 50 mm, contact time 0.1 s and a force of 40 g.

2.7. Total available carbohydrates

The total available carbohydrate level from freeze-dried breadcrumb samples was determined spectrophotometrically by using an enzyme kit (K-TSTA) supplied by Megazyme, Ireland.

2.8. Sugar

Sugar levels of flour, dough and bread crumb were analysed for sucrose, maltose, glucose and fructose by an Agilent 1260 high performance liquid chromatography system (HPLC) with a Hi-Plex H column (Agilent, Cork, Ireland) coupled to a refractive index detector (RID). The sugars were extracted with distilled water for 20 min under shaking and clarified with Carrez I and II. The HPLC analysis was performed at 25 °C column temperature with water (HPLC-grade) at a flow rate of 0.6 mL/min.