

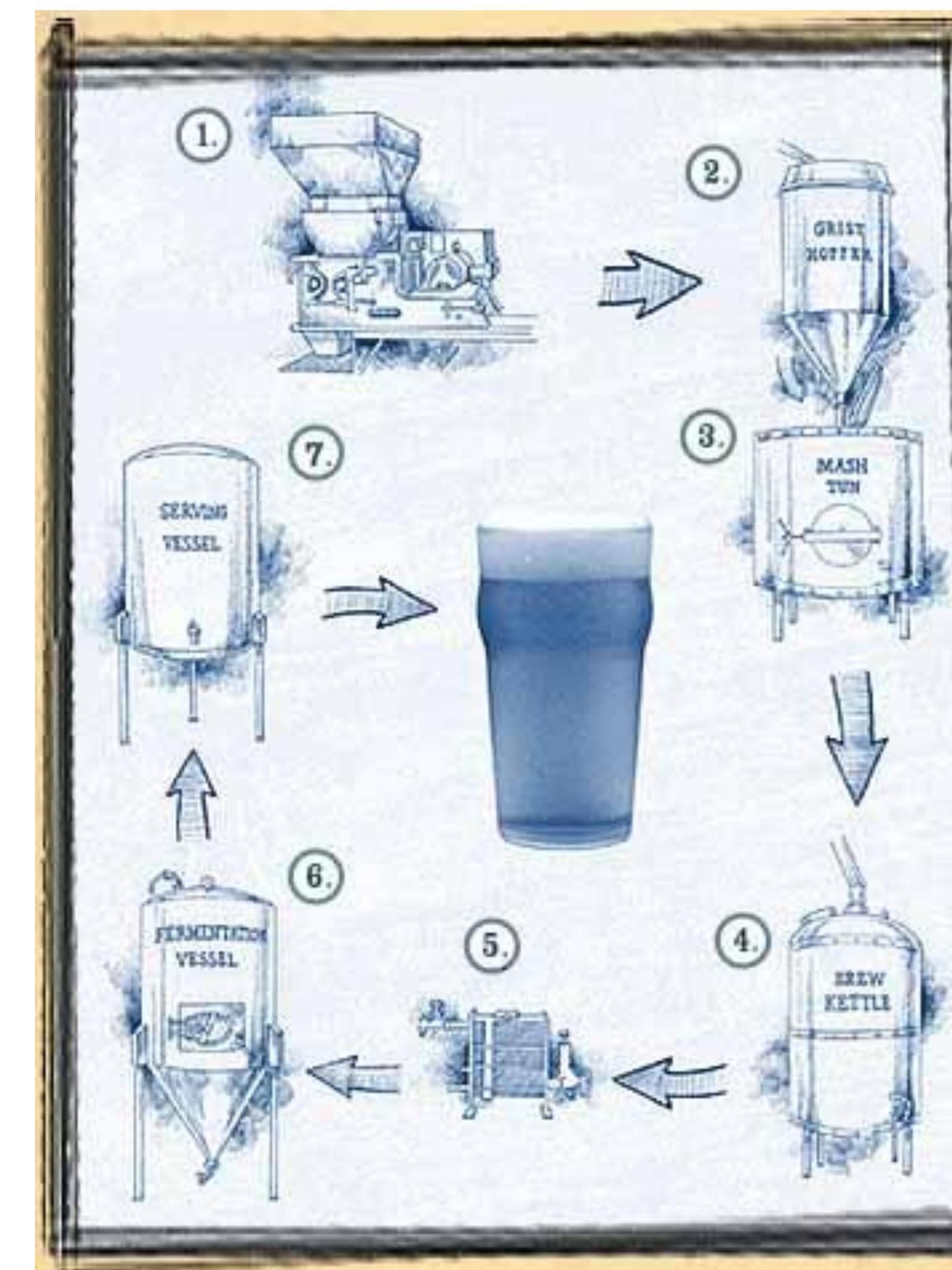
The Worldwide Beer Market

- The global beer market had a value of \$470.8 billion in 2009 and is projected to have a value of \$496.6 billion in 2014. [1]
- The global beer market had a volume of 39.2 billion gallons in 2009 and is projected to have a volume of 42.4 billion gallons in 2014.
- The standard lager makes up 55.5% of the total market value.
- Europe accounts for 47.8% of the total market value.
- Anheuser-Busch InBev is the largest brewing company with 25.4% of the total market volume.



The Brewing Process

- Malted grains are poured in a mill with two stainless steel rollers to crush the husks. [3]
- The milled grain is stored in a *Grist Hopper*. It then drops through a collimating collar that wets it with hot water.
- The wet grain goes into the *mash tun* where additional hot water is added. The mixture is stirred until the desired sugar content is reached. The resulting sweet liquid is called *wort*.



- The wort is pumped to the *brew kettle* where it is boiled and the hops are added, which adds bitterness and aroma to the beer.
- The wort is next pumped through a heat exchanger where it is brought to 65 degrees Fahrenheit. The cold water used to cool the wort is then recycled and stored in hot water tanks.
- The cooled wort is pumped to a fermentation tank where yeast is then added to start fermenting the wort. The mixture is kept at about 65 degrees F for approximately 5 days. It is then cooled down to about 32 degrees F and held for another seven to ten days.



- The beer is then transferred to serving tanks where it awaits to be served.

Brewers' Spent Grain (BSG)

The chemical composition of BSG varies according to barley variety, when it is harvested, and how it is malted and mashed. However, it is in general rich in protein and fiber, which account for around 20 and 70% of its composition, respectively.

TABLE I. Chemical composition of brewers' spent grain (BSG).

Component (% dry wt)	BSG ^a	BSG ^b
Cellulose	25.4	16.8
Arabinoxylan	21.8	28.4
Lignin	11.9	27.8
Protein	24.0	15.2
Lipid	10.6	Nd
Ash	2.4	4.6

^a From Kanauchi et al. (2001).

^b From Mussatto and Roberto (2005).

The Grains

The primary grain used in brewing beer is barley. Barley grain is rich in starch and proteins and consists of three main parts: the germ, the endosperm, and the grain covering. Before brewing, harvested barley is sorted by size, and each size is malted (roasted) separately. [2]

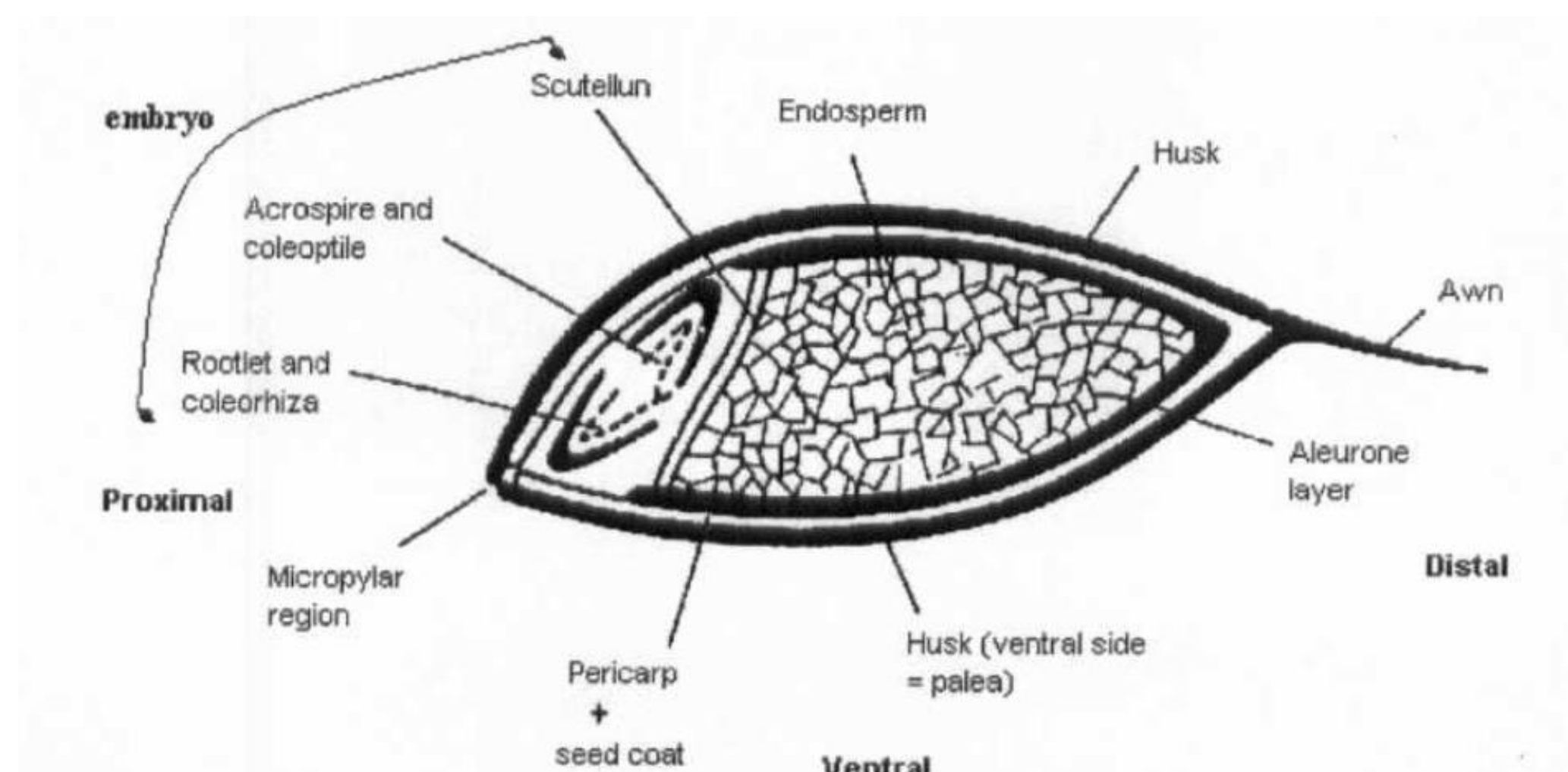
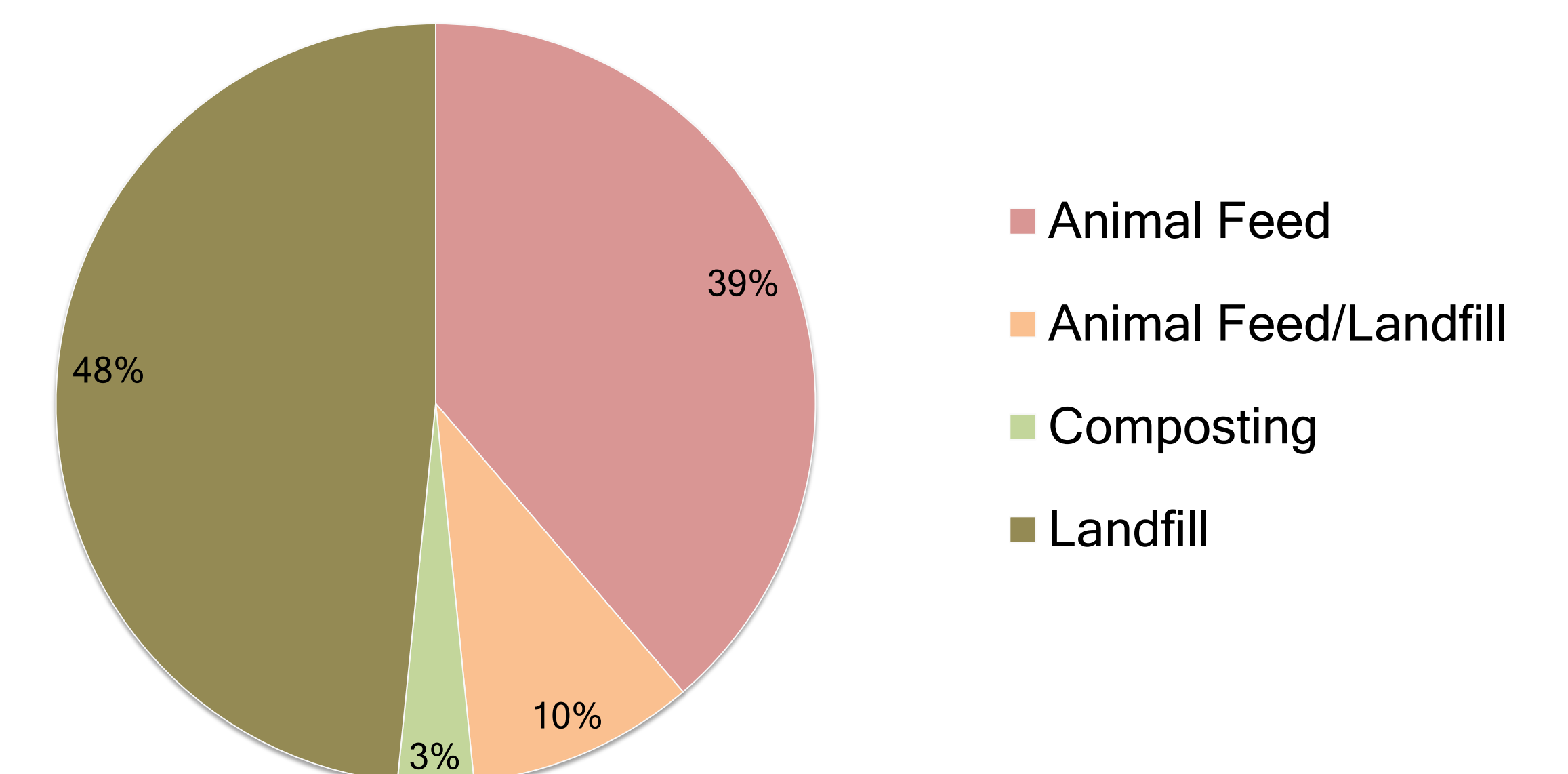


Fig. 1. Schematic representation of a barley kernel in longitudinal section (adapted from Lewis and Young, 1995).

Current Uses of BSG in Chicago

31 breweries across Chicago were surveyed for their uses of BSG; the results are seen below. The purpose of IPRO 340 was to analyze these options, as well as alternatives, and to give a final report to our sponsor, Master Brewer Tim Rock Bottom Breweries.



References

- [1] *Beer: Global Industry Guide*. ResearchAndMarkets. www.researchandmarkets.com
- [2] A.I. Mussatto, G. Dragone, I.C. Roberto, *Brewer's spent grain: generation, characteristics and potential applications*. Journal of Cereal Science. 43 (2006) 1-14

- [3] *Brewing Process*. Rock Bottom Brewery. www.rockbottom.com