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Review Article

CHEMICAL COMPOSITION OF BREWERS SPENT GRAIN – A REVIEW

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Introduction

Scientists are searching for an alternate source of cheaper agro-industrial by product with high protein. One such alternative source is Brewery spent grain (BSG) which contains 21-29% crude protein on dry matter basis (Su and Heng-Chun, 1995; Westendorf and Wohlt, 2002) and costing lower than rice bran, coconut oil cakes, (Huige, 1994 and Santos *et al*., 2003) reported that the chemical composition of BSG varies with barley variety, time of harvest, malting, mashing conditions, adjuncts added and brewing technology. This article intends to review the chemical composition of brewers spent grain.

Chemical composition of Brewers spent grain

Drymatter and Moisture

Murdock *et al.* (1981) and Dong and Ogle (2003) who reported DM content of Brewers spent grain ranging from 26 to 31 percent. Senthilkumar *et al*. (2010) reported that the DM content of brewers spent grain was 29.15 percent. Dhiman et al. (2003) reported a DM value of 33.6 per cent, while Rogers et al. (1986) and Belibasakis and Tsirgogianni (1996) reported lower DM values of 18.6 and 19.3 percent, respectively.

Brewers Spent grains contains 75-80 percent water and deteriorate rapidly due to the growth of bacteria, yeasts and fungi. It is mandatory to use them as soon as possible after reception and to make sure that they are in good condition before utilization (Wyss, 1997; Wadhwa et al., 1995, Aning et al., 1994).

Crude protein

Murdock et al. (1981), Rogers et al. (1986), Belibasakis and Tirgogianni (1996) and Dong and Ogle (2003) reported that the CP values ranging from 23.4 to 27.4 percent. A higher (30.1 per cent) and lower (20.0 per cent) CP values were reported by Crickenberger and

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Johnson (1982) and Ranjhan (1998) respectively. Senthilkumar *et al*. (2010) reported that the CP content of brewery waste was 24.34 percent.

Ether extract

The EE content of brewers spent grain was 10.6 percent reported by Dong and Ogle (2003) while Senthilkumar *et al*. (2010) reported lower value of 5.19 percent.

Total Ash

Ranjhan (1998) and Dong and Ogle (2003) reported that total ash content of BSG ranges from 3-5 percent where as Senthilkumar *et al* (2010) reported 5.76 percent

Acid insoluble ash

Senthilkumar *et al* (2010) reported that the acid insoluble ash content was 4.42 percent

Nitrogen free extract (NFE)

Dong and Ogle (2003) reported that NFE values ranging from 41.2 to 48.1 percent, and (Senthilkumar *et al*., 2010) reported 45.07 percent where as Ranjhan (1998) reported higher value of 53.9 percent. The gross energy content of brewery waste was 3543.52 kcal/kg (Senthilkumar *et al.,* 2010).

Neutral Detergent Fibre (NDF)

Senthilkumar *et al* (2010) reported that the NDF content of brewery waste was 54.64 percent. Murdock *et al*. (1981) and Dong and Ogle (2003) also reported similar NDF values ranging from 50 to 55 percent. Higher NDF value of 70 percent was reported by Dhiman *et al.* (2003). On contrary, Belibasakis and Tsirgogianni (1996) reported lower NDF values between 40 to 50 percent.

Acid Detergent Fibre (ADF)

Murdock *et al*. (1981) and Rogers *et al.* (1986) reported that ADF content of BSG was 20 percent which is lower than 24.68 percent as reported by Senthilkumar *et al* (2010). However, Dong and Ogle (2003) reported lower value of 17.5 percent and Dhiman *et al*. (2003) reported higher ADF value of 27.7 percent.

Hemicellulose

Senthilkumar et al (2010) reported that the hemicellulose and cellulose contents of brewery spent grain was 29.96 percent and 13.14 percent, respectively. Valverde (1994) reported a higher hemicellulose content of 39 percent for BSG

Lignin

Senthilkumar et al (2010) reported that the lignin content of brewers spent grain was

7.12 percent, which is higher to the value of 4 to 5 percent as reported by Murdock *et al.* (1981).

Mineral

High amounts of calcium, magnesium, silicon and phosphorus were reported to be 1038.5, 687.5, 242 and 1977 ppm, respectively (Khidzir et al., 2010), while other minerals (such as cobalt, copper, iron, manganese, potassium, selenium, sodium and sulphur) detected in BSG were of lower concentrations.

Vitamin

vitamins include (ppm): biotin (0.1), choline (1800), folic acid (0.2), niacin (44),pantothenic acid (8.5), riboflavin (1.5), thiamine (0.7) and pyridoxine (0.7) (Huige 1994; Mussatto et al., 2006). Also, protein bound amino acids have been detected including the essential ones (Essien and Udotong, 2008).

Chemical composition (% on DMB) of Brewers grain reported by different authors

Parameters	**1**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**	**11**
DM	21.0	26.0	21.7	29.2	-	-	-	-	-	-	-
CP	26	29.6	18	24.3	24	22	31	15	21	24	23
RDP % of CP	40.9	35.5	-	-	-	-	-	-	-	-	-
CF	15.3	12	11.3	19.6	17	15.9	18.1	20	13.3	15.1	-
ASH	-	-	1.2	-	-	5	5	5	3	4	2.4
NDF	47	48.3	-	54.6	-	-	-	-	-	-	-
ADF	23	23.5	-	24.7	-	-	-	-	-	-	-
Crude fat	10.8	9.1	-	19.6	6	12	9	-	11	-	10.6
EE	-	-	-	5.9	-	-	-	-	-	-	-
Cellulose	-	-	-	-	17	15	15	17	11	15	25
Lignin	-	-	-	-	4	13	6	28	7	-	12
TDN	70	73.9	79.1	-	-	-	-	-	-	-	-

(1) NRC (2001), (2) Thomas *et al*. (2010), (3) Nissanka *et al*. (2010), (4) Senthilkumar (2009), (5) Faulds *et al*. (2004), (6) Serena and Knudsen (2007), (7) Dung *et al*. (2002), (8) Mussatto and Roberto (2005), (9) Laws and Waites (1986), (10) Beldman *et al*. (1987), (11) Kanouchi *et al.* (2001).

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