Annex 9-4

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Corn Malt Extract for Alcoholic and Non-Alcoholic Beverages

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Malt powder prepared from germinated corn was toasted in an oven at 50°C to increase its flavour. Malt extract was fermented by Baker's yeast and a malty flavoured dark brown coloured, clear alcoholic beverage was obtained. Alcohol strength of the beverage increased and the non-fermented carbohydrate decreased, when the extract was treated with glucoamylase and yeast simultaneously. Non-alcoholic beverage was prepared by mixing concentrated malt extract with milk powder, sucrose, cocoa powder and glucose.

Keywords: Alcoholic beverages, Corn, Malt extract, Malt powder, Non-alcoholic beverage.

Cereal malts are important sources for fermentation process in brewing industry and for the preparation of different non-alcoholic beverages. Studies have been carried out by many workers on malting of rice (Sivaganeshan et al. 1993), wheat (Lineback and Ponpipom 1977), barely (Briggs 1963; Careens et al. 1988; Sparrow 1965), oat and millet (Lineback and Ponpipom 1977). Malted barley is a well known product and is used in the production of non-alcoholic beverages presently available in market. Since the endogenous enzymes degrade starch and proteins during malting, malted barley in alcoholic beverages enhances the flavour, taste and nutritive value of the drinks. Barley is not cultivated in Sri Lanka and therefore, its substitution with locally cultivated corn would save foreign exchange. The average yield of corn in Sri Lanka is in the range of one metric tonne per hectare (Agricultural Implementation Programme 1996). In Sri Lanka, corn grains are mainly used in animal and poultry feeds and to some extent is utilized for human consumption. Although this cereal is not extensively cultivated in Sri Lanka at present, the climatic and soil conditions of the dry zone are ideal for its cultivation on commercial scale. Hence, studies were carried out for preparing alcoholic and non-alcoholic beverages, utilizing malted corn instead of malted barley.

Materials : Corn was purchased from local market and α – amylase (Termamyl 60L^{R}, activity 67.5 KNU g^{-1}) and glucoamylase (Spirit amylase 150L^{R}, activity 150 AGU g^{-1}) were from NOVO Industries, Denmark. A commercial yeast preparation (Fermipan, Gist-Brocades, Holland) was used. Sodium metabisulphite was of analytical grade.

Malting of corn and preparation of malt powder: Corn (1 kg) was steeped in tap water (2l), containing 150 ppm sodium metabisulphite at room temperature for 18 h. After draining the water, the grains were kept in moistened muslin cloth bag, where the height of the grains was between 5 and 8 cm. Grains were malted for five days, while maintaining the moisture between 30–40%, by spraying with tap water containing 150 ppm sodium metabisulphite. The malted grains were sun-dried for 2 days and powdered in a commercial mill. To improve the flavour, the powder was roasted in an oven at 50°C for 1 h. Malt powder was analyzed for proteins by Kjeldhal method (Pearson 1976), carbohydrates by acid hydrolysis, reducing sugars by diniytroalicylic acid method (Arasaratnam 1989) and moisture by oven drying at 80°C (Pearson 1976).

Determination of malt amylase activity : Malt amylase (endogenous amylase) activity was determined as follows: Soluble enzyme was extracted by mixing 1 g of malt powder with distilled water (4 ml) for 30 min and the strained extract was centrifuged. The supernatant was used as enzyme source. Supernatant (1 ml) was incubated with 2.5 ml of 40 g l^{-1} soluble starch at pH 4.0 and 60°C for 30 min. Reducing sugars produced were determined by dinitrosalicylic acid method. The activity of malt amylase is expressed as μ mole glucose min^{-1} kg^{-1} malt powder.

Preparation of malt extract : Corn malt powder in suspension (1 kg in 4 l water, pH 4.0) was hydrolyzed by endogenous amylase for 30 min at 60°C. The pH was adjusted to 7.0 and incubated with 5.0 l^{-1} α-amylase (endogenous amylase, 60 KNU l^{-1}) at 95°C for 2 h. Extraction was carried out using a screw press. The residue was mixed

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With 500 ml of distilled water and re–extracted. The 1st and 2nd extracts were analysed for total carbohydrates, reducing sugars and proteins (Lowry et al. 1951). Proteins, residual carbohydrate and moisture contents of the residue were also determined.

Calcium estimation : Calcium in the extracts was determined by o–cresolphthalein complexone method as follows: Calcium solution of different concentrations (0.5–3.75 mmol l^{-1}, 50 µl) was mixed with 5 ml of o–cresolphthalein complexone reagent (ethanediol, 76 ml; 2 –amino –2 methyl -1– propanol, 26 ml; o – cresolphthalein complexone, 30 mg and 8–hydroxquionoline, 1 g dissolved in double distilled water and made up to 1 litre). The colour developed was measured at 575 nm against the reagent blank. The test samples were treated similarly.

Preparation of alcoholic beverages

Fermentation of malt extract : After adjusting the pH of malt extract to 4.5, Baker's yeast Fermipan, 5 g l^{-1}) was added and incubated at room temperature for 72 h. The alcohol (dichromate reduction method, (Varley et al. 1980) residual reducing sugars (Miller 1959) and total carbohydrate contents were determined.

Simultaneous saccharification and fermentation of malt extract : To malt extract (100 ml), 2 g of glucoamylase (300 AGU l^{-1}) and 5 g l^{-1} yeast (Fermipan) were added and incubated at room temperature for 72 h. Ethanol produced and residual carbohydrates in the media were estimated.

Preparation of non–alcoholic beverages : The malt extract was dried in a sand bath at 60°C for 2 h. The malt powder (500 g) was mixed with commercially available milk powder (150 g), sucrose (250 g), cocoa powder (50 g) and glucose (50 g). The mixture was dried and granulated in a domestic grinder.

Malt powder and malt extract : Malt powder prepared by the above procedure contained (g kg^{-1}) moisture, total carbohydrates and total proteins 10, 660 and 90, respectively and 304 x 10^2 µ mole glucose min^{-1} kg^{-1} malt powder endogenous amylase activity (Table 1). Roasting of the malt powder improved its flavour and organoleptic properties. Composition of the malt extracts and the residue is given in Table 1. About 90.6% of the carbohydrates in the malt powder (66 g/100g) was recovered in malt extract and the rest remained in the residue. The dextrose equivalents of both extracts 1 and 2 were same (75.6%), while the residue was rich in proteins (22%).

TABLE 1. COMPOSITION OF MALT POWDER MALT EXTRACTS 1 AND 2 AND THE RESIDUE

Parameters	Malt powder	*Malt extract 1	2	Residue
Volume/weight also 1/kg	–	3.0	0.5	0.2
Reducing sugars, g %	ND	13.6	8.8	ND
Total carbohydrates, g %	66.0	18.0	11.6	17.0
Dextrose equivalent (DE)	ND	75.6	75.6	ND
Proteins, g %	9.0	0.5	0.13	22.0
Calcium, g %	ND	0.02	0.02	ND
Moisture, g %	10.0	75.0	88.0	58.0
Endogenous amylase activity m moles glucose min^{-1} kg^{-1} malt powder	304 x 10^2			

* The extracts were obtained by successive extractions of malt powder (1 kg) with 4 lit and 0.5 lit of tap water

Alcoholic beverage : Malt extract was fermented by Baker's yeast and the analysis of the spent medium for alcohol and residual sugar is given in Fig. 1. Malt extract used in this experiment had a total carbohydrate content of 180 g l^{-1}. At 72 h, the yield of ethanol was 33.3% (yield = ethanol produced/theoretical ethanol that could be produced from the total carbohydrate content of the medium X 100) and the reducing sugar utilized was 64 g l^{-1} (Table 1). The efficiency of alcohol production was 93.8% (efficiency = ethanol produced/theoretical amount of ethanol that could be produced from the sugar utilized X 100). Therefore, it was decided to convert the un–utilizable carbohydrates in malt

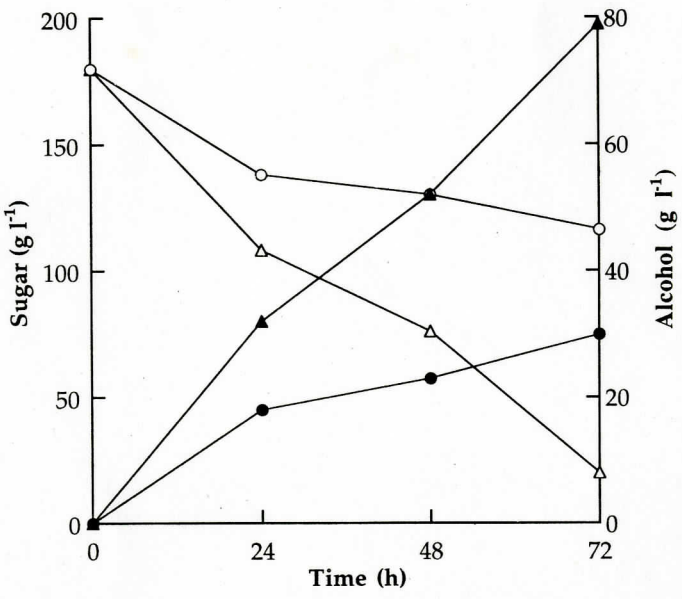

Fig. 1: Composition of the changes in alcohol (closed symbol) and sugar (open symbol) contents in malt extract during fermentation by Baker's yeast in presence (triangle) and absence (circle) of glucoamylase

extract into fermentable sugar by adding glucoamylase, an exoamylase, which acts on the poly–and oligo–saccharides in a sequential order (Fogarty 1983).

Fermentation is inhibited by high concentration of glucose and other fermentable sugars (Arasaratnam 1989). Thus, inoculation with yeast after the complete conversion of non–utilizable carbohydrates to fermentable sugars by glucoamylase would not be beneficial. Hence, to the malt extract, glucoamylase (2 g l^{-1}, 300 AGU l^{-1}) was added along with 5 g l^{-1} yeast. During this simultaneous saccharification and fermentation process, sugar utilization was faster (Fig. 1) than under control condition. The yield of ethanol and efficiency of ethanol production in the presence of glucoamylase were 87.3% and 98.7%, respectively. This indicates that added glucoamylase had hydrolyzed the non–fermentable sugars into fermentable sugars and improved ethanol production. The yeast was allowed to settle and the drink obtained was a clear malty flavoured alcohol.

Non–alcohol beverage : The malt extract was dried gradually in a sand bath (60°C, 2 h). Gradual drying was done to avoid caramelization of sugars in the extract. Due to careful drying of the malt extract in the sand bath, caramelization was avoided and the drinks did not have 'burning' smell. When additional ingredients were added, the mixture became semi–solid. It was further dried and broken into granules using a grinder keeping the temperature around 30°C. When this was mixed with either hot or cold water, it dissolved readily and gave a uniform drink with good organoleptic properties. The reconstituting property was comparable to that of the commercially available malt food.

Unlabelled alcoholic and non–alcoholic beverages prepared in the laboratory and commercially available drinks were distributed to the staff and students at the Faculty Medicine, University of Jaffna. The laboratory products were better preferred than the commercial products. Work is in progress to scale up this process.

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