To study the filterability and quality of raw sugar for refining

Sociology, Slavery

To Study the Filterability and Quality of Raw sugar for Refining ABSTRACT

This study was particularly designed to evaluate the quality parameters of raw sugar which ultimately affect the filterability of raw sugar. It is a cane sugar which has been minimally processed and product of the first stage of cane sugar refining process which has some very distinctive characteristics. Filterability of raw sugars is one of the primary sugar quality parameters.

To the refiner, the filterability of raw melt is important as it directly influences factory throughout. The physico-chemical characteristics of sugar including moisture, polarization, reducing sugar, ash contents, color constituents, microbial examination (Total colony count and yeast) and sensory evaluation such as appearance, odour and texture were determined. The results obtained from physico-chemical analysis showed that these parameters were affected significantly among the samples of raw sugars.

The microbial analysis showed that the total colony count and the yeast were also affected significantly among the samples while in sensory evaluation appearance was affected significantly whereas texture and odour were affected non-significantly among the samples of the raw sugars. It can be concluded from the results that sample four was observed to have a good quality while sample six had the opposite result to that of sample four and was considered to have a very low quality. Keywords: Raw Sugar Refinery, Operational Concept and Quality Perspectives Name: Zia-ud-Din Regd.

No: 2006-ag-1861 National Institute ofFoodScience and TechnologyUniversity of Agriculture Faisalabad SUPERVISORY COMMITTEE ChairmanDr. Ghulam Rasool MemberDr. M. Atif Randhawa MemberDr. Muhammad Sharif

INTRODUCTION Raw sugar is an intermediate product of refining and affination process of sugar manufacturing that consists of pale yellow to brown sugar crystals covered with a film of syrup. This is infact, an intermediate stage in the production of sugar, having sucrose and water contents 95-97 and 0. 25-1. 1%, respectively. It is of yellowish brown colour due to the presence of molasses (3. %) and have burnt flavour with coarsely crystalline (Javaid et al. , 2011). The sugarcane (Saccharum officinarum L.) is a commonly distributed plant and is one of the most significant source of sugar in Pakistan. Current reports have shed light into numerous biological properties of sugarcane and its resulting products. Fresh sugarcane juice is widespread in Pakistan as an inexpensive and sweet beverage. It is becoming a fashion juice and thirst satisfying drink served at roadside stalls, canteens and cafeterias throughout the country during the harvest season (Ali et al. 2001). The sugarcane is a thick, tall perennial grass that is grown in tropical or subtropical region. In the leaves sugar is synthesized that is either used as a energy source for growth of plant or is sent to the stalks for storage. In the stalks the sweet sap is the source of sugar. The reed accumulates sugar to about 15 percent of its weight. About 2600000 tons of sugar per year is yielded by the sugar cane. Other sugar crops for sugar production involve sweet sorghum, honey, sugar maple and corn sugar (Dalziel et al. , 1999).

Sugarcane is grown in Kharif season and is one of the main cash crops of Pakistan. It delivers raw material to sugar industries and sugar associated products. For the rural community of the country, it produces income and services. Vital items for industries like sugar, chipboard and paper, sugarcane helps in their value addition. Its share is 3. 6 percent in agriculture and 0. 8 percent in GDP. For the year 2009-10, an area of 943 thousand hectares is under sugarcane cultivation which is 8. 4 percent less as compared to the previous year (1029 thousand hectares).

Production of the sugarcane for the year 2009-10 is assessed to be 49. 4 million tons, in contrast to 50 million tons previous year ultimately the production is reduced to 1. 3 percent. Key factors involved for low productions are canal water scarcity, electricity shortage, area under wheat crop during 2008-09 is maximum ultimately confining the sugarcane acreage, lower prices for the sugarcane crop in the previous year and higher inputs rates also restrict the farming community from growing sugarcane crop (GOP, 2009-2010).

The keeping quality of sugar was studied keeping in the view the process of drying played a pivotal role. By keeping the sugar under humid conditions, microbial decomposition along with loss of sugar occurred rendering the quality of sugar impure. After the process of drying, the process of polarization becomes augmented and the notorious effects of microorganisms become less. If the sugar is wet when fed into the dryer, large amount of heat is required for the process of drying the sugar. Sample purity plays a vital role in determination of overall moisture contents of the sugar sample.

If the size of the crystals of sugar becomes enlarge, ultimately increasing the moisture percentage of the sugar sample (Javaid et al. , 2011). An experiment was conducted which showed the presence of iron particle and bagacillo causes the physical hazards and biological contamination in the finished products respectively. Following essential steps should be taken in order to keep the juice clear and free from the particles of bagacillo i. e. pre-juice heating (106 oC or above), required chemical dozing at clarifier, pass the clarified juice from 0. 25 mm rotary screen. They both are ISO (i. . International Standardization Organization) 22000: 2005, Critical Control Points (CCP's) of Food Safety Management System, covers HACCP (i. e. Hazard Analysis Critical Control Points) (Javaid et al. , 2011). The parameters were studied and an experiment was conducted in which pre-treatments of sugarcane bagasse for the production of fermentable sugar was carried out. They studied the effects of particle size, NaOH concentration, temperature and liquid to solid ratio (LSR) on the production of reducing sugars and sonication time on delignification using Placket-Burman design.

They concluded that sugarcane bagasse that was pre-treated with ultra-sound assisted alkaline pre-treatments showed superior yield and production of reducing sugars as compared to the commercial pre-treatments. They also concluded that the most striking feature of the ultra-sound assisted alkaline pre-treatments was the improved efficacy during the pre-treatment time and temperature that were kept reduced during the process. They also found that the feasibility and instalment of this process on a larger scale need energy optimization and appropriate reactors design (Velmurugan and Muthukumar 2012).

Sugar beet pulp was utilized as a support for immobilization of yeast (Saccharomyces cerevisiae L.) cells to produce bioethanol. They found the method of immobilization of cells as simple, cheap and easy to carry out. They concluded that even without the supplementation of the nutrient, the production of bioethanol in an efficient manner from thick juice of sugar beet utilizing immobilized yeast cells on sugar beet pulp is possible in repeated batch mode. A maximum ethanol concentration of 52. 26 g/l, yield of 0. 446g/g was achieved in the thick juice substrate of seventh fermentation batch.

However, the molasses was found to be less suitable medium for the production of the ethanol fermentation for more than three batches because of the accumulation of the coloured compounds that cause cell leakage from the support ultimately affected the metabolism of the immobilized yeast cells. They also determined that the dry sugar beet pulp plays a significant role during the support of immobilized yeast cell for the production of bioethanol and the dry sugar beet pulp can be used as a protein source in the animal feeds (Vucurovic and Razmovski 2012).

MATERIALS AND METHODS Samples of raw sugar were procured from sugarcane industry/local market. The research was conducted at the National Institute of Food Science andTechnologyin university of agriculture Faisalabad. Ash contents Total ash contents were determined by taking 5 gram sample in the china dish and placed on low flame while the mass is thoroughly charred, then the sample was heated in muffle furnace at 500+500C until white ash was obtained. This ash was cooled in the desiccator and weighed in percentage using the following formula: Total ash = Weight of ash ? 100 Weight of sample Colour Colour value was determined with colour meter (Nauhaus color test- II, Neotec). It was first calibrated with the standards having lower and upper limits (51-70 respectively). Then the sample were filled in the Petri plate and the surface was made smooth by removing the sample material from the petri plate, to get the optimum reflection of light, emerged by thephotocells of the colour meter, reading was noted from the display. Sample readings were compared with the standards. Grain size of crystals

According to SI specifications, crystals were graded into five sizes. In the grain size analysis, 100 g of sugar was taken on sieves, placed on a nest of sieves with a lid on the top of sieve and received at the bottom and was shaken for five minutes on a mechanical sieve shaker. The weight of each sample in gram was taken in the percentage of the sugar retained in the particular sieve. From the values, the accumulative percentage is calculated and compared. Filterability of the samples Filterability was determined by following the standard method enlisted in AOAC (2000). 5 g raw sugar sample was taken and dissolved in 50 ml water until the brix of the solution was 300. The time was noted during the filtration of each sample. Then the percent filterability was determined using the following formula: % Filterability = amount of the filtered solution ? 100 Total volume of solution Moisture Moisture was determined by taking 10 g of sample and drying it in a hot air oven at 100+50C for about 3 hours as recommended by ICUMSA. The loss in weight was the moisture contents calculated by using the following formula: moisture = loss of weight during drying ? 100 Weight of sample The data thus collected were subjected to statistical analysis using completely randomized design (CRD) and ANOVA techniques as described by

Steel et al. , (1997) to check the effect of different parameters on the quality of raw sugar RESULTS AND DISCUSSION Ash contents The results for statistical analysis regarding analysis of variance for the ash contents are presented in table 4. 3a. It is shown by the data that the values are affected highly significant for the ash contents in the samples of raw sugar.

The mean values for the ash contents are shown in the table 4. 3b. It can be established from the data presented in the table 4. 3b that the highest value for the ash contents was found for sample six which was 0. 73 percent while the lowest value was recorded for the samples one, two and five. So the value for the ash contents were found to be decreasing for the samples in the order of T6> T1T2T5> T3T4. While it had been established by many sugar technologists that the contents of ash in the samples of sugar should not exceed 0. 5 percent.

These results were reviewed by Chauhan et al. , (2011) and after doing further analysis he determined that the ash contents in some of the raw sugar is in high concentration because the raw sugar was affined for purification at different temperatures for the quality improvement. Colour Agudo et al. , (2002) determined that the crystals colour of the sugar is greatly affected by the colour and purity level of the pan feed liquor. Generally the process of crystallization removes 90-96 percent of colour. The feed liquor having low level of colour gave the sugar with better colour.

The process of refining in the processing of sugar utilize the phosphatation, carbonation, bone char, affination (mechanical separation of colour), granular carbon and ion exchange resin for the removal of colour before the process of sugar boiling (crystallization) for the production of sugar. According to ICUMSA (2007) standards, the maximum colour range of the raw sugar should be in the range of 400-600. The statistical analysis results regarding analysis of variance for colour contents in different samples of raw sugar is presented in the table 4. a. The results showed that the colour values were affected highly significant among the samples of raw sugar. The mean values for the colour contents in different raw sugar samples are shown in the table 4. 6b. The data showed that the maximum colour was observed for sample six and lowest was recorded for sample one. These results are in line with the above mentioned ICUMSA standards. Gyura et al. , (2007) proposed that some factors played an important role in the determination of colour and these factors affect the colour of the sugar.

Some of these factors include sugar crystal size, colour types, ash constituents, boiling time, crystal distribution, polysaccharides and colour and purity of pan feed liquor. These factors determine the overall quality of sugar. So it was concluded that the increase value for the colour contents in the sample six was due to the occurrence of these impurities due to improper affination process or other refining process ultimately making it a low quality raw sugar. Size of crystals The results regarding analysis of variance for the size of crystals of different raw sugar samples have been shown in the table 4. a. The statistical analysis showed that the relationship between different raw sugar samples regarding the size of crystals were affected highly significant. The mean values for size of crystals among raw sugar samples had been presented in table 4. 5b. According to Jennings (1967), the size of crystals for the raw sugar should be between 0. 35-0. 60

mm. These research findings are in agreement with the research outcomes of the present study. The size of crystals for different raw sugar samples were in the range of 0. 39-0. 58 mm.

The sample three and four had the maximum size of crystal of 0. 56 and 0. 58 mm respectively. While the minimum size of crystal was recorded for sample two which had a size of 0. 39 mm. As the standard size ranges from 0. 35-0. 60 mm, so all the samples fell in the range of standard values. It can be concluded from the review that during the sugar production optimal control is required for the growth of crystals in the crystallization stage is a vital factor for the production of sugar crystals that have the size according to specification. Argaw et al. (2006) stated that the process of growth and size of crystals can be observed by implementing varieties of different methods which involve visual inspections as well as indirect measurements. It was proposed by Beucher (1992) that the sieve method used for the assessment of the size of crystals of the raw sugar samples was well recognized for the quality determination on international scale. He stated that the sieve method is simple, easy to perform and a straight forward method which can be utilized in the productionenvironmentand this method require a modest technology.

The demerits of this method that was established by the scientist were the large amount of samples and preparations required for the analysis and a more time consuming process making this a laborious method ultimately making this a difficult process to perform. It was also concluded that the size of crystals played a significant role in determining the quality of sugarcane and raw sugar produce. Filterability The results regarding the analysis of variance for the filterability of various raw sugar samples obtained from different sugar industries.

The statistical analysis showed that the filterability was affected highly significant for different raw sugar samples. The mean values for the filterability of different raw sugar samples are presented in table 4. 10b. Javaid et al. , (2011) stated that the impurity factor, starch and insoluble suspended matter in raw sugar have impact great influence on filtering quality of processed and unprocessed liquor. The starch has two main components i. e. traight chain amylase and branched chain amylopectin, the amylase: amylopectin ratio, the difference in charge characteristic with pH in solution, an important physico-chemical characteristic with reference to its role in filtration. High starch and low filterability process, therefore, have negative effects on clarification process that leads to the development of ash and colour in sugar. They also stated that the existence of starch in raw sugar influences and has effects on filtration, doubled the viscosity of low grade massecuite and impede the process of crystallization.

The filterability of melted raw sugar has great effect on the refinery output however; when it does then it decrease the filtrate brix that leads to decrease the melting rate and viscosity as well. Consumption of excess steam in the evaporator or pan had an influence on the production during which the production suffered. Moisture The analysis for variance for the moisture contents of several raw sugar samples regarding the results have been presented in table 4. 1a. The statistical data narrated that the moisture contents of several raw sugar samples were affected highly significant.

The values for the mean of the moisture contents for various raw sugar samples are shown in the table 4. 1b. It had been determined by Javaid et al. , (2011) that the moisture contents of the raw sugar were 40 percent during the examination. These findings of the research are parallel with the results of the present study. The moisture contents of the different raw sugar samples were in the range of 0. 20 to 0. 76 percent. The data also showed that the highest moisture contents were found in sample six followed by sample one while lowest values were recorded for sample four.

Chen et al. , (1993) established that the moisture contents of the sugar is adaptable because of the non-reducing sugars during the process of manufacturing and also because of the contribution of the different types of agronomic factors such as storage, moisture, type of irrigation, soil conditions, season of harvesting and variety of cane crop. Such factors are involved during the analysis and study of present research. So the present difference can be attributed to these factors. Table 1: Mean values for Ash Contents, Colour, Size of Crystals, Filterability and Moisture Treatments | Ash Contents | Colour | Size of Crystals | Filterability | Moisture | | T1 | 0. 5333ab | 418. 33c | 0. 4067c | 58. 333b | 0. 5333ab | | T2 | 0. 3000ab | 422. 33bc | 0. 3933c | 56. 133b | 0. 4000bc | | T3 | 0. 1667b | 420. 00c | 0. 600a | 67. 000a | 0. 2333c | | T4 | 0. 1333b | 447. 00abc | 0. 5867a | 70. 467a | 0. 2000c | | T5 | 0. 3000ab | 490. 67ab | 0. 4667b | 38. 000c | 0. 3000bc | | T6 | 0. 7333a | 503. 33a | 0. 4733b | 33. 000c | 0. 7667a | CONCLUSION

Thus it can be concluded from the present research that the sample four was the best regarding the sugar quality while sample from one to three were also of desire quality and quite near to the standards and were collected from the sugarcane industries. While sample six was collected from the cottage industry was proved to be of very poor quality. REFERENCES Agudo, J. A. G. , M. T. G. Cubero, G. G. Benito and M. P. Miranda. 2002. Removal of coloured compounds from sugar solution by adsorption on to anionic resins equilibrium and kinetic study. Sep. Purfi. Technol. , 29(3): 199-205.

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