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Short Communication

Development of Stabilized Vegetable Amylases for Enzymatic Desizing of Woven Fabric with Starch Containing Sizes

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Abstract. Investigations have been carried out on the development of stabilized vegetable amylases for enzymatic desizing of woven fabric. Vegetable amylases from barley and germinated mango seeds were extracted and stabilized for industrial use. The desizing of woven cotton fabric was carried out with these amylases. Their desizing performance was also compared with commercially available enzymes. As a result of this study, highly active and stabilized amylases were obtained from barley and germinated mango seeds. The method used for the enzyme recovery was also noted to give good yield from both the sources of plant origin.

Keywords: barley amylase, germinated mango seed amylase, desizing enzyme, enzyme stabilization, woven fabric

The first crude use of enzymes in textile processing was done in 1857 when starch-sized cloth was soaked with liquor containing barley. Later, in 1900, this process was slightly improved by using malt extract. The process of enzymatic desizng, using animal and bacterial amylases, was introduced in many textile factories in 1912 (Cavaco and Gubitz, 2003). Weaving is one of the oldest arts known. Woven fabric consists of sets of yarns, interlaced at right angle in some established sequence or pattern. The yarns that run parallel to the selvage or the longer diameters of a bolt of fabric are called warp yarns, those that run crosswise of the fabric are called weft yarns. Starch-containing sizes are applied to the warp yarn of woven fabrics to assist in the weaving process, which however must be removed prior to dyeing and printing processes. The removal of the starch size from the cotton yarn is called the desizing process (Shenai, 1991). Amylase enzyme that specifically acts on starch is considered to be the favourable option for the solubilization of starch into glucose and maltose (Bergmeyer, 1974). Enzymatic desizing is now regarded as the most safe and economical method. In order to reduce the cost of production of the desizing enzymes, an attempt has been made to extract amylases from the indigenous resources available in Pakistan. For this purpose, germinated barley and mango seeds were used for the extraction of amylase. The study on this aspect is reported here.

Extraction of barley amylase. Barely is one of the earliest known grains. It is grown in tropical regions of Pakistan. Barley is used in soups, in animal feed, in the production of malt for beer and commercial alcohol (Brooks, 1962). Selected seeds of barley were steeped in water for 2-7 days. Steeping for three days at 20-25 °C was found to be the optimum period. The steeped seeds were dried for 3 days at room temperature. After drying, the barley seeds were spread over cotton sheet and turned periodically to maintain uniformity of moisture, temperature and proper aeration. Germination started, after 4 days, which continued upto 10-15 days in dark conditions at 20-25 °C. By checking the amylase activity everyday it was found that the activity was low during first 7 days, while the optimum activity was reached after 11 days, and decline was observed after 15 days. Amylase activity was less when germination was allowed to proceed during daylight. The loss of moisture during the germination process, was replenished by sprinkling water. The germination process was terminated after 11 days by freezing the germinated seeds at -10 °C for 24 h. For better extraction of amylases the germinated seeds were crushed and soaked in equal amount of water (1:1) for 10-15 days. Best results were obtained after 10-11 days of soaking. For preservation, 0.1-0.2% sodium benzoate was used. After 10-11 days, extract was removed by filtration. From 1 kg of germinated barley seeds, about 470 g malt extract was obtained. It was a light brown liquid extract.

Extraction of amylase from germinated mango seeds. Selected seeds of mango were collected and washed. After washing, the seeds were buried in soil for germination. After 15 days, the seed stone broke and shoots appeared. When shoots grew up, the germinated seeds were separated from the hard stone, washed and frozen for 24 hours at -10 °C. These germinated seeds were ground and soaked in equal amount of water (1:1) in dark conditions for 7 days at 20-25 °C. For preser-

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vation, 0.1-0.2% sodium benzoate was used. After 7 days the water extract was separated by filtration through a fine cloth. The filtrate was passed through a bed of activated carbon to remove the brownish colour. From 1 kg of germinated mango seeds about 300 g enzyme extract was obtained.

The exhaust enzymatic desizing methods of AATCC (103-1989). The exhaust method is a simple method usually used for enzymatic desizing. Malt amylase usually requires 3 h to desize the fabric. By appropriate changes in washings, the enzyme concentration, temperature, wetting agents and electrolytes, the desizing time can be reduced. Certain electrolytes were added to the amylase extracts or the desizing liquor to improve desizing efficiency so as to shorten the desizing duration. Sodium chloride or calcium chloride were used for this purpose. When sodium or calcium chloride was used in the desizing liquor, the thermal resistance as well as the solubility of amylases increased, as these salts combine with the carboxyl groups, allowing the amylases to form a complex with starch and eventually to break it down (Peters, 1975).

Before starting the desizing process it was necessary to prewash the fabric for 8-10 min at 90-95 °C in 2 g/l detergent. This resulted in the swelling of starch and facilitated the subsequent amylase action. After pre-washing, the fabric was squeezed as much as possible. The desizing cycles were repeated with different types of enzyme preparations for the sake of comparison.

Rotary dyeing machine tube was filled with the desizing liquor and the machine started. When the temperature of 40 °C was achieved, the machine was stopped and the prewashed and squeezed fabric was impregnated into the desizing solution. This warm desizing solution provided the necessary conditions for amylase to quickly penetrate into the fabric. The machine was started again and temperature was raised to 60-62 °C. When temperature reached 62 °C, the breakdown of starch started. After the time required (2 h for barley and 3 h for germinated mango seed amylases), the machine was stopped and the fabric was washed. This washing process is very important for removing the degraded starch from the fabric. It was best obtained by a subsequent washing with a detergent or soda ash 2 g/l at 95-100 °C for 15 min. Cold washing coagulates the liquefied starch on the fabric, which is very difficult to remove otherwise. After detergent washing, the fabric was rinsed with warm water at 60 °C for 10 min followed by a cold rinse.

The pad batch enzymatic desizing method. The pad batch method is also simple and is well used in the textile industry. Before starting the desizing process, fabric was prewashed for 8-10 min at 90-95 °C in 2 g/l detergent or soda ash. It swelled the starch and facilitated the subsequent amylase action. The fabric was squeezed firmly before impregnation. The desizing liquor was heated up to 60-62 °C. This heating facilitated the penetration of the amylases into the fabric. The desizing liquor was poured in the padder machine. The padding cycles were repeated with different types of enzyme preparations.

The padder machine was started and the squeezed fabric was padded for 100% pick-up. After padding, the fabric was wrapped in polyethylene bags and kept revolving throughout the batching time for getting even distribution of the enzyme liquor. After 12 h, the polyethylene bags were unwrapped and the fabric was washed at 95-100 °C for 15 min with 2 g/l soda ash or a suitable detergent. After the detergent washing, the fabric was rinsed with warm water at 60 °C for 10 min followed by a cold rinse.

Detection of amylase activity. The activity of amylase enzymes was measured in terms of time required to breakdown the size starches. This digestion was checked by colour development, using iodine solution as the indicator (1 g iodine crystals and 15 g potassium iodide were dissolved in 1 litre of water). This solution was applied on the processed cloth. If the colour of the cloth changed to brown it showed the complete removal of starch and if it turned blue or violet then this showed that the size starch was still present on the fabric (Booth, 1968).

The enzyme extracts, obtained during the present studies, took 2 h (barley extract) and 3 h (germinated mango seed extract) in the exhaust process, and 12 h with both these extracts in the pad batch process. The two commercial extracts, namely, Bactasol MTN (Clarriant) and Nervanase 3x (ICI) completed the fabric desizing within the same time as was taken by the barley extract in the two types of processes. These findings are in agreement with the observations on fabric desizing reported by Troja (1970), Frantisek (1964) and Hans (1938; 1936). It was also noted that whereas the germinated mango seed extract took slightly longer period for fabric desizing, the extract concentration required was about twice more (30-35 g/l) in comparison with the barley extract and the two commercial preparations (10-15 g/l). The observations reported in the present study, therefore, indicate the possibility of commercial application of crude enzyme extracts made from cheap or waste plant materials for the desizing of fabrics in the textile industry.

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