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Short Communication

Development and Applications of Animal Amylases for Enzymatic Desizing of Woven Fabric

A. Farhan Khan* and Shoib Arif

Textile Institute of Pakistan, PQA Campus: EZ/1/p-8 Eastern Zone, Bin Qasim, Karachi, Pakistan

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Abstract. Investigations have been carried out on the development of stabilized crude animal amylases for enzymatic desizing of woven fabric. Animal amylases from pancreas were extracted and stabilized for industrial use. The extracted pancreatic amylases took 1 h in exhaust process and 6 h in pad batch process for the desizing of woven fabric. The desizing performance of these amylases was also compared with commercially available enzymes. The present studies have yielded highly active and stabilized amylases from animal pancreas. The method used for the enzyme recovery was also noted to give good yield of the enzyme from animal origin.

Keywords: animal amylases, desizing enzyme, enzyme stabilization, woven fabric desizing

Interest in the use of enzymes in textile processing has significantly enhanced during recent years. The first crude use of enzymes in textile processing was reported in 1857, when starch-sized cloth was soaked with liquor containing barley. This process was later improved slightly in 1900, when barley was replaced by malt extract. The process of enzymatic desizing, using animal and bacterial amylases, was introduced in many textile factories in 1912 (Cavaco Paulo and Gubitz, 2003). The enzymatic desizing in textile processing is preferable as enzymes are environment-friendly, non-toxic and the wastewater from enzymatic treatment is biodegradable. They also require mild temperature and pH for their activity, and have the potential of replacing harsh chemicals such as acids and alkalis.

Weaving 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, but must be removed prior to dyeing and printing processes. The removal of size from the cotton yarn is called the desizing process (Shenai, 1991; Hans, 1938; 1936). The amylase group of enzymes, that specifically act on starch, are 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 enzymes, an attempt has been made to extract amylases from indigenous resources available in Pakistan. For this purpose, animal pancreas was used for the extraction of amylases.

The characteristic parameters of the 100% pure sized-cotton (plain weave) fabric used in the present studies were: area weight, 170 g/m^2; warp yarn count, 40 (tex); weft yarn count, 40 (tex). The water used during the desizing process had the following qualities: total hardness, 319 ppm; TDS, 545 ppm; pH, 7.6. The desizing process was performed in a high temperature rotary machine (closed vessel) with automatic temperature programming and agitation. A horizontal padder machine was used for padding.

Animal pancreas from slaughterhouse waste was collected and washed. For the better extraction of crude amylases, the pancreas was ground, and soaked in equal amount of water (1:1) for 2-10 h in dark conditions at 25 °C, 35 °C and 40 °C. It was found that the activity was low during the first 8 h at 25 °C, 35 °C and 40 °C, while the optimum activity was reached after 10 h at 25 °C, which declined after 10 h at 40 °C. Amylase activity was less when the soaking was allowed to proceed during daylight. For the preservation of crude enzyme extract, 0.1-0.2% sodium benzoate, sodium chloride and calcium chloride were used. It was found that sodium benzoate provided stabilization of the enzyme extract for about six months at 25 °C in air tight and dark containers. After 10 h, the extract was removed by filtration. From 1 Kg of waste pancreas 350 g enzyme extract was obtained. It was a cream coloured liquid extract.

The exhaust method, which is a popular and simple method of enzymatic desizing, was used in the present studies. Be-

*Author for correspondence: E-mail: khanabdulfarhan@yahoo.com

fore starting the desizing process, the fabric was pre-washed for 8-10 min at 90-95 °C in 2 g per litre 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 (Table 1). A rotary dyeing machine tube was filled with the desizing liquor and the machine was started. When the temperature of 40 °C was achieved, the machine was stopped and the pre-washed 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 the temperature was raised to 60-62 °C. When temperature reached 62 °C, the breakdown of starch started. After 1 h, 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 achieved by a subsequent detergent or soda ash (2 g per litre) washing at 95-100 °C for 15 min. Cold washing coagulated the liquefied starch on the fabric, which becomes difficult to remove. After detergent washing, the fabric was rinsed with warm water at 60 °C for 10 min, followed by a cold rinse.

The pad batch method is another simple and well used method in the textile industry. Before starting the desizing process with pad method, the fabric was pre-washed for 8-10 min at 90-95 °C with 2 g per litre detergent or soda ash. This resulted in swelling of 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 amylase into the fabric. The desizing liquor was poured in the padder machine. The padding cycles were repeated with different types of enzyme preparations (Table 2). 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 6 h the polyethylene bags were unwrapped and the fabric was washed at 95-100 °C for 15 min with 2 g per litre soda ash or a suitable detergent. After the detergent washing, the desiged fabric was rinsed with warm water at 60 °C for 10 min followed by a cold rinse.

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 + 15 g potassium iodide dissolved in 1 litre 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 starch was still present on the fabric (Booth, 1968).

The extraction of crude amylases from the pancreatic fluids is a simple method for the production of industrial enzymes. Animal pancreas from slaughterhouse waste has no commercial use presently, though it is rich in amylases. It was observed during the present study that the activity of pancreatic amylases was maximum after 10 h of soaking in water at 25 °C in dark conditions and the extract so obtained took 1 h in exhaust process, and 6 h in pad batch process for the desizing of woven fabric. 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

Table 1. Comparison of the performance of crude pancreatic amylases with enzymes commercially available for desizing (exhaust method)

Recipe	Bactasol* MTN (Clarriant)	Nervanase* 3x (ICI)	Pancreatic** amylase enzyme
Liquor ratio	20:1	20:1	20:1
Concentration (g/l)	10-15	10-15	10-15
Wetting agent (g/l)	5-10	5-10	5-10
NaCl (g/l)	4	4	4
pH	6.5	6.5	6.5
Temp (°C)	60	60	60
Time (h)	1	1	1
Iodine test	brown	brown	brown

* = commercial desizing enzymatic preparations; ** = crude enzyme preparation extracted from slaughterhouse waste pancreas

Table 2. Comparison the performance of crude pancreatic amylases with enzymes commercially available for desizing (pad batch method)

Recipe	Bactasol* MTN (Clarriant)	Nervanase* 3x (ICI)	Pancreatic** amylase enzyme
Concentration (g/l)	10-15	10-15	10-15
Wetting agent (g/l)	5-10	5-10	5-10
NaCl (g/l)	4	4	4
pH	6.5	6.5	6.5
Temp (°C)	60	60	60
Time (h)	6	6	6
Iodine test	brown	brown	brown

* = commercial desizing enzymatic preparations; ** = crude enzyme preparation extracted from slaughterhouse waste pancreas

pancreatic extract in the two types of processes reported here (Tables 1 and 2). The observations reported in the present study, therefore, indicate the possibility of commercial application of crude enzyme extracts made from a cheap or waste animal material for the desizing of fabrics in the textile industry.

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