Biodetergents

1. For households
2. Industrial cleaning (mebranes, filters, heating equipments)
3. Institutional laundry (hospitals, slaughterhauses)
4. For dishwashers

Origin and character of soil:

„From own production“:

proteins, lipids, lipoprotein komlpexes,

epidermal „debris“

From food: animal or plant origin

Composition of detergents

- Washing customs

component	Function	compound	Liquid (%)	Powder (%)
surfaktants	Emulsification ↓ surface tension	Ionogenic nonionogenic	10 – 50 (10 – 30)	10 - 20
Activation additives	pH, buffer ↓water hardness Stabilsation, chelating agents	TPPS NTA citrate, soda zeolites	0 – 10 (5 – 15)	20 - 45
Bleaching agents	Oxidation of dyes	Perborates Percarbonates EDTA	0	13 - 28
Enzymes	↑ effectivness	Proteases, amylases, lipases, celulases, oxidases etc.	0 – 6 (0 – 1)	0,5 – 1,5
others	builders, stabilizers, antifoaming agents, bleaches, parfumes	Síran sodný mýdla		Do 100
pH 1% solution			7,5 - 9	9,5 - 11

Surfaktans: ionogenic- alkylbenzensulphates, alkoholsulphates, (laurylpolyglykolethersulphate),

nonionogenic: alkoholethoxylates

Compatibility of enzymes with detergents

Enzymes for detergents:

Active in the pH range 7 - 11
Active in the temperature range 4 – 60 °C
Compatible with surface active components, oxidative agents, resistent to proteolysis

<u>In washing solution:</u> **denaturation**
chemical modification

<u>In detergent:</u>

Powder: **storage temperature**
humidity
oxidative agents (brighteners)
Liquid: **surfactants (tensides)**
stabilised by Ca^{2+} addition
proteolysis
lowering water content (propylenglykol)
reversible inhibitors (borate, AA, protein hydrolyzates)

Proteases - only serine type

Cleavage of proteinaceous soils → peptides are usually more soluble

Properties of some technical preparations:

5.2 En

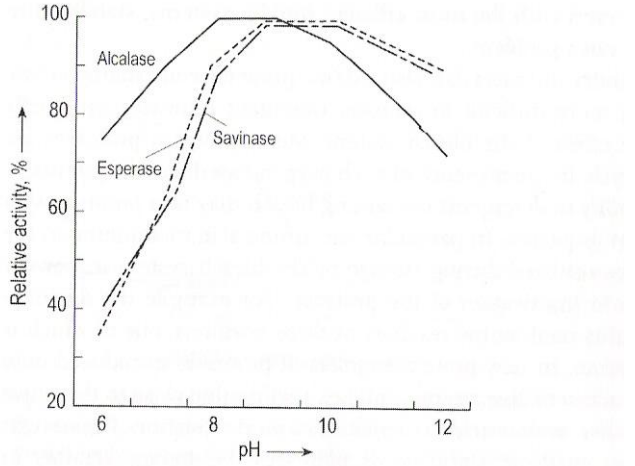


Figure 58. pH-dependent activity of different detergent proteases at 25 °C, 10 min reaction time, DMC substrate [588-590].

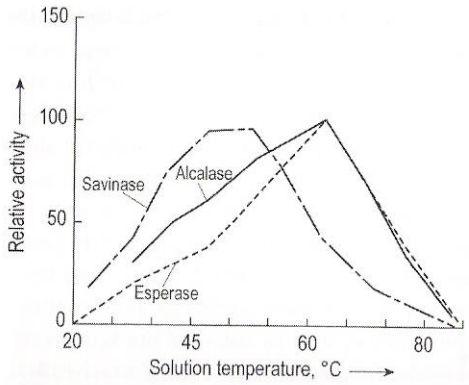
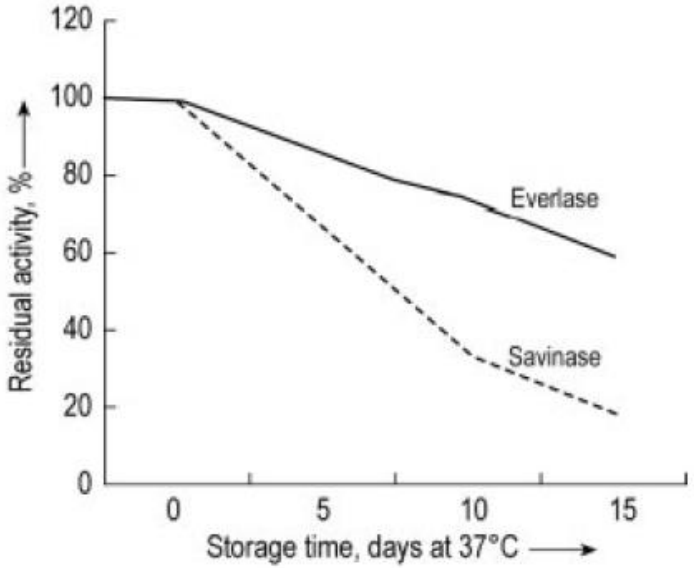


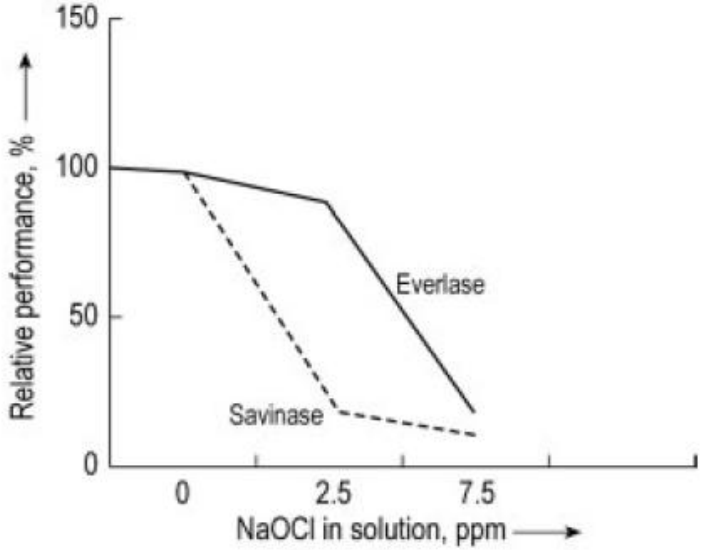
Figure 59. Temperature-dependent activity of different detergent proteases in solution at pH 8.5 (Alcalase) and 10.1 (Savinase, Esperase), 10 min reaction time, DMC substrate [588-590].

Table 22. Examples of commercially available detergent proteases (Novozymes) [587–591]

Product name	Microorganism	pH application range	Temperature application range
Alcalase	*Bacillus* species	6–10	10–80
Esperase	*Bacillus* species	7–12	10–80
Everlase	GM *Bacillus* spp.	8–11	15–80
Savinase	GM *Bacillus* spp.	8–11	15–75
Durazym	GM *Bacillus* spp.	8–11	15–70

stabilization……





Savinase → Everlase -1 mutation Met222/Ala

Lipases

Lipolase

Lipolase ultra

Asp96 x leu

Lipoprime – effective in1.cycle

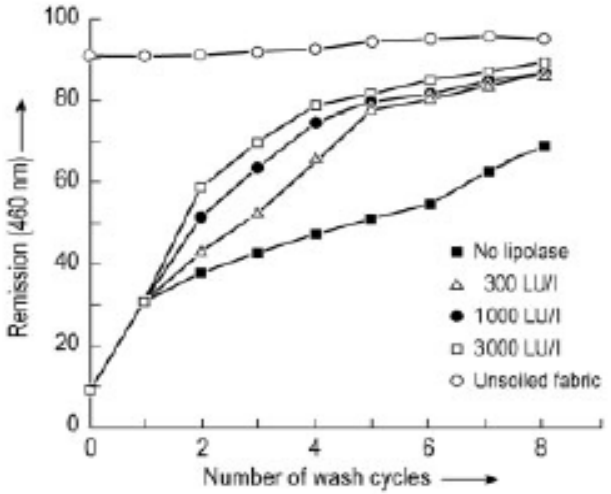


Figure 66. Multi-cycle wash performance of lipase in detergents. Stain removal as function of number of wash cycles. European wash conditions 5 g/L powder detergent, 30 °C, 20 min, wash at pH 9.7. Polyester swatch soiled with lard fat plus Sudan red [610]. LU/L = Lipase Units per Liter

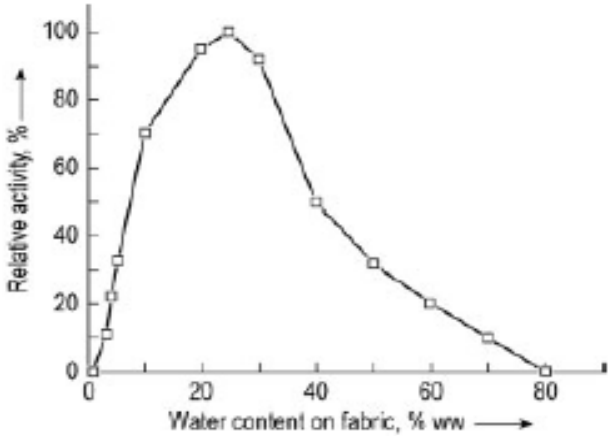


Figure 67. Lipase performance in the laundry drying step. Relative enzyme activity during drying after a European wash and one rinse with tap water [612].

Celulases

Celluzyme, Carezyme, Endolase - Thermomyces lanuginosus

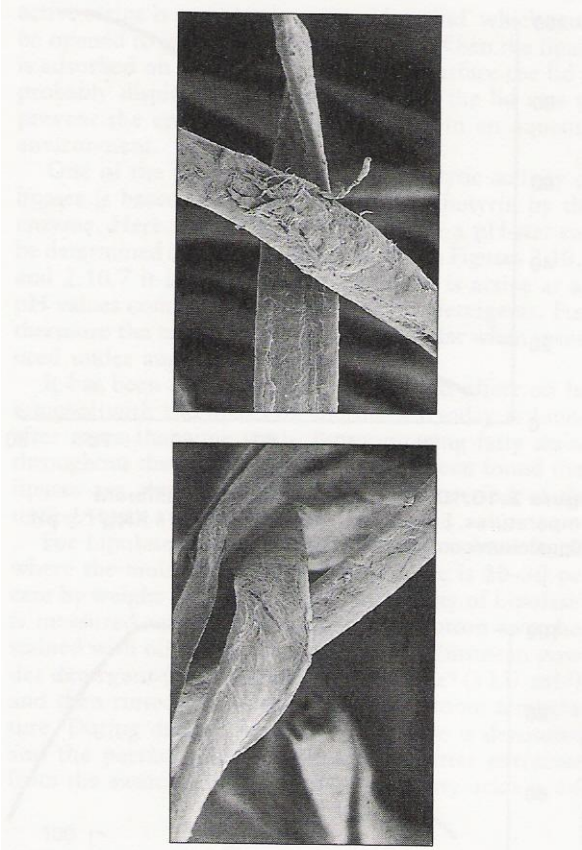


Figure 2.10.13 SEM pictures of cotton fibres before and after treatment with Celluzyme

Amylasy –

škrobové nečistoty, želatinizace, tvorba filmů (amylosa)

Termamyl, Fungamyl, BAN, Duramyl

Current development in the field:

Pectolytic enzymes - removal of fruit spots (Pectaway, Pectawash)

Mannanase – removal of mannans – food thickeners - (Mannaway

First used in Ariel 2000

- Oxidoreductases - peroxidases, laccase, LOX
- production of oxidazing agent in situ – replacement of bleaches

Detergents for industrial and institutional cleaning – homogenous soiling

Brewery, production of fruit juices, dairy industry, hospitals etc.

Example: heating surfaces in dairies

burnt-on milk: products of Maillards reactions + lipids

+ milk stone – complex of calcium phospahate and proteins

Removal : 0.5 -1% NaOH, surfactants, EDTA, 75 – 85°C, 0.5 – 1%HNO_3 + surfactants

Using enzymes:

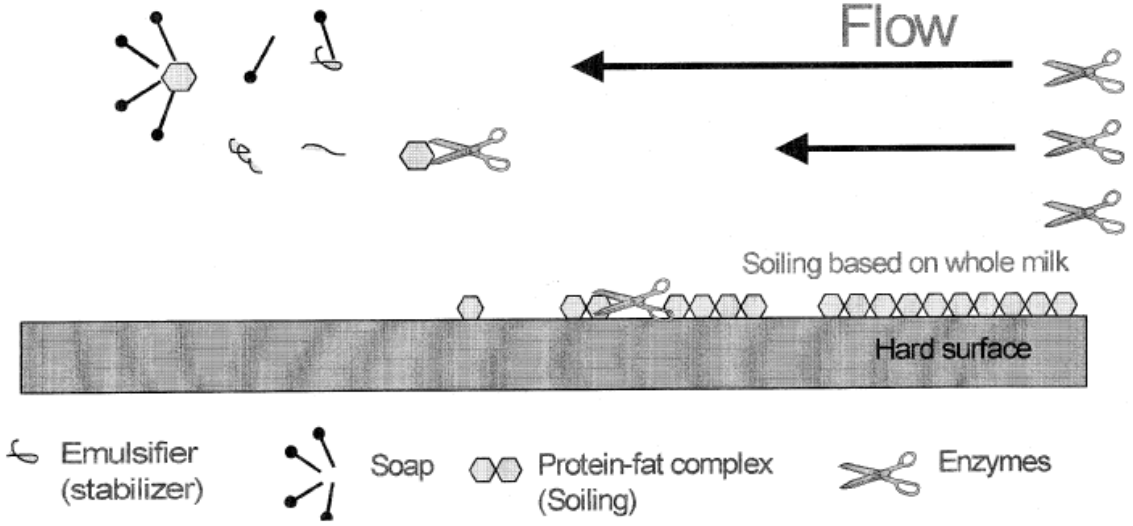


FIG. 1. *In situ* cleaning effects of protease + lipase.

Agriculture

Feeding – using of less valuable fodder material (

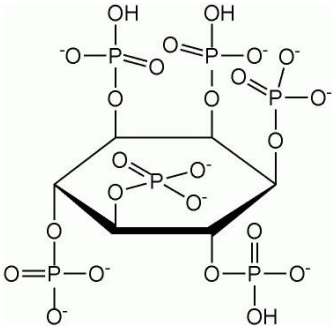
Monogastric (cereals) x polygastric (green fodder)

- formulation of fodders → celulases, hemicelulases (xylanases) – release of nutritive components(starch, proteins) , β-glukanases – consistency of excrements (poultry)
- enzymes as digestives - proteases, amylases, glucanases

Removal of ANF – protease inhibitors, increase of digestibility

- protection of the environment – phytase

myo-inositol hexaphosphate phosphohydrolase (EC 3.1.3.8)

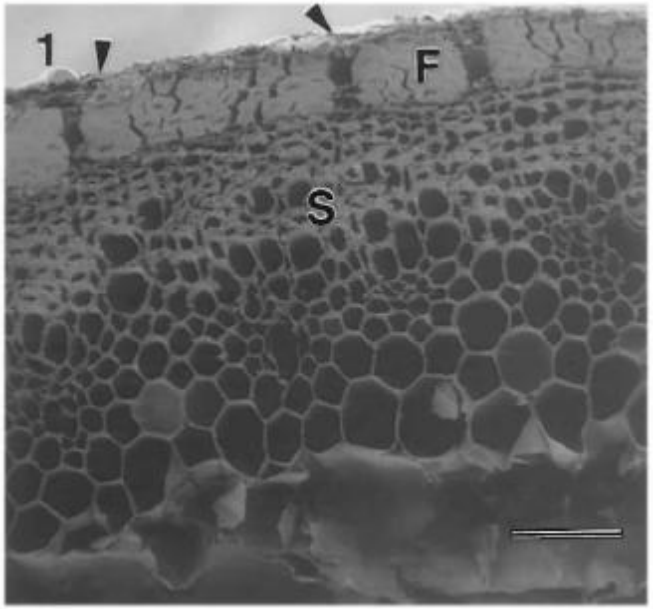


60 – 80 % P = IP_6

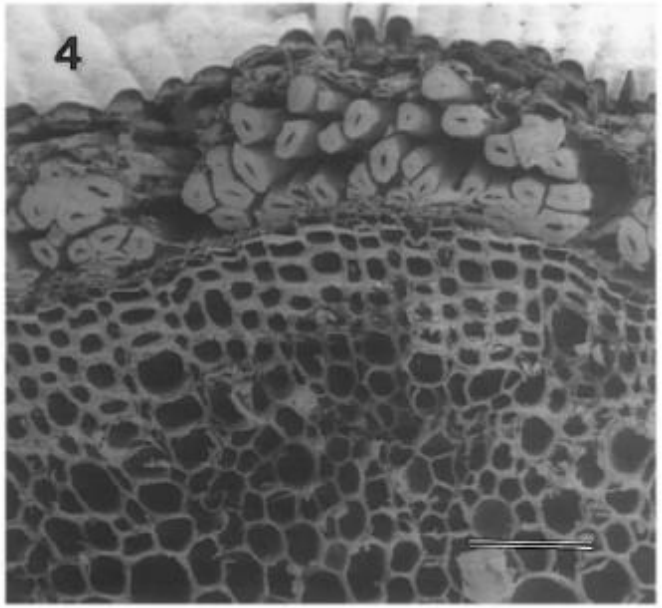
Chelating agent – ↓Ca,Cu,Zn,Mg

Flax retting

Enzyme retting - Flaxzyme, Viscozyme



control

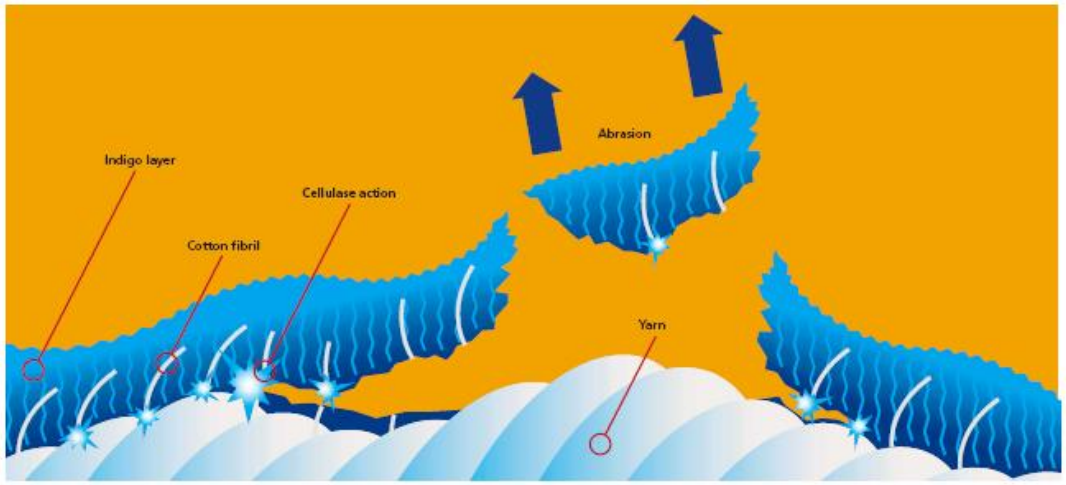


8h of enzyme treatment

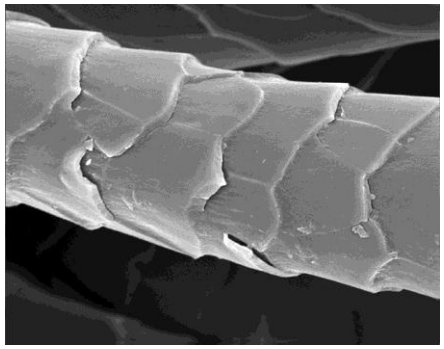
Textile industry

1. Removal of starch from textiles before bleaching and dyeing (amylases)
2. biostoning (celulases)
3. Bio-polishing of cotton textiles (celulases)
4. Surface modification of wool (proteases)
5. Scouring – removal of cell wall residues from cotton fabrics (pectolytic enyzmes)

Bio-stoning of denime textiles



Wool processing – to avoid felting and shrinkage during washing

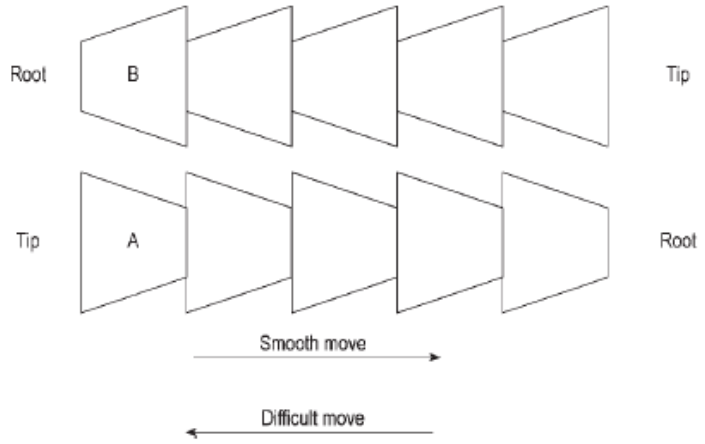


Alpha keratin – helical structure with number of disulphide bonds
Step - like structure of fiber surface

- oxidation with hypochlorite (NaClO)
- coating surface with polymers (chitosan)
- combination of both

Enzymes more environmentally friendly:
- proteases
- transglutaminase

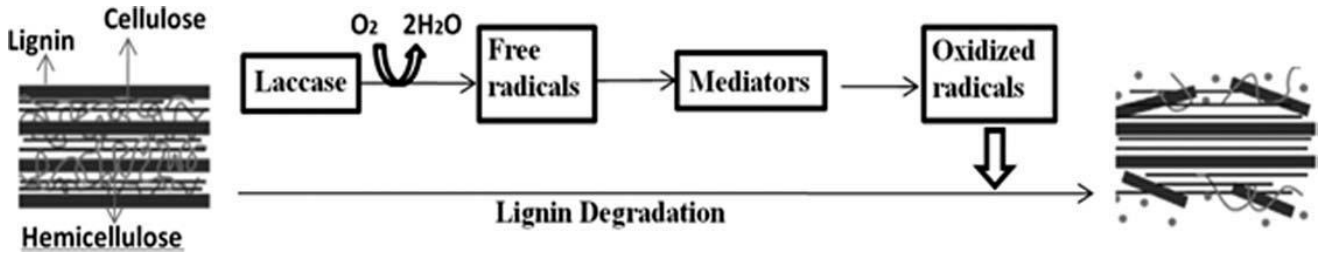
- Risk (loss of weight)



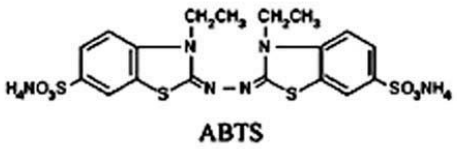
Wood processing for paper industry

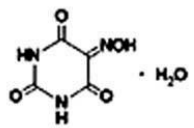
- Removal of lignin and hemicellulose components (xylanases and laccase)
- Bleaching (laccase, peroxidases Lip, MnP)
- Removal of pitch (lipases, phospholipases)
- Paper finishing – removal of starch from the surface (amylases)

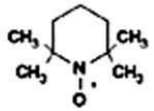
Removal of lignin components and bleaching

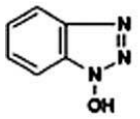


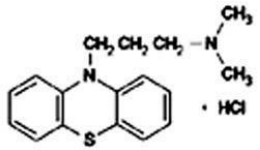
Possible mediators

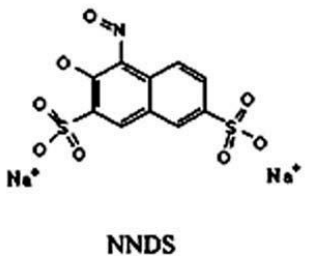


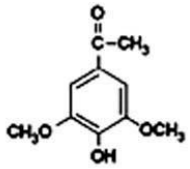


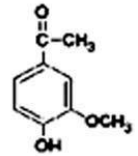


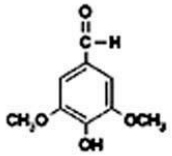


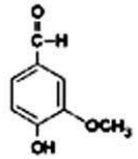


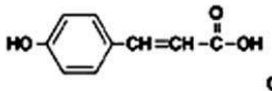


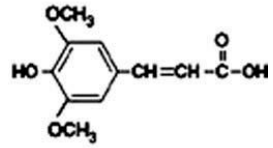


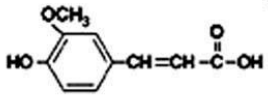




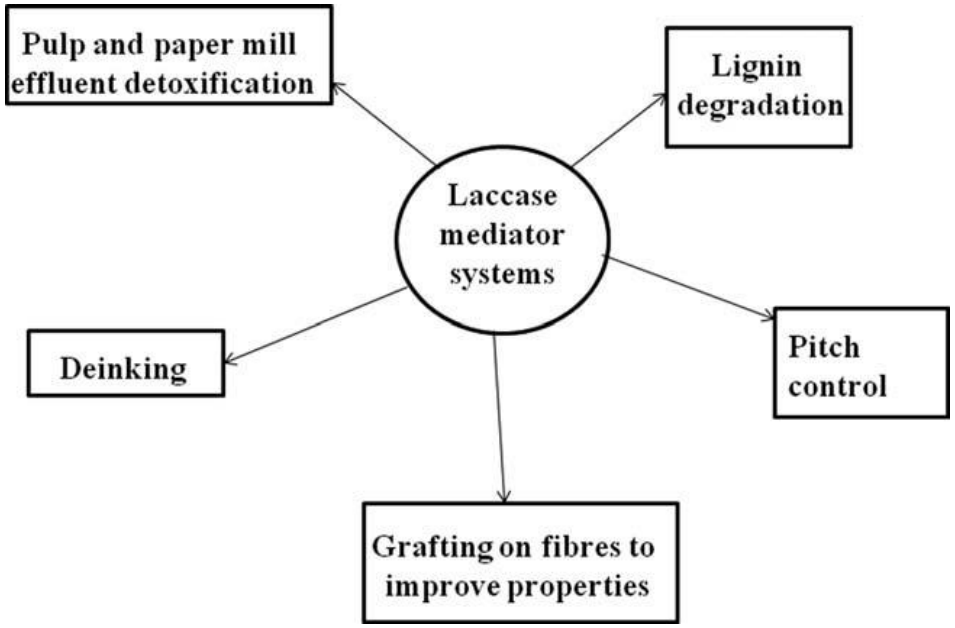








Usage of laccase mediator system in paper industry



Flow sheet of LMS