

Dynamics of Agricultural Biotechnology

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A S Chandel and R M Kamal



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Dairy and milk products

2393 MATHUR, BN. 1990. **Prospects for biotechnological applications in dairy processing in industry for enhanced productivity.** *Indian Dairyman*, 42: 3, 101-106; 4 ref.

Possible uses of biotechnology to improve productivity in the dairy industry are discussed, with particular reference to the following applications: production of stable genetic recombinants of lactic starter bacteria with specific characteristics; use of immobilized enzyme reactors for producing high-fructose spray-dried whey; production of microbial polysaccharides suitable for application in cultured milk products; production of lactic acid bacteria with anticholesterolaemic or anticarcinogenic properties; production of infant formulae with enhanced bioprotective properties; and biotechnological approaches to fermented milk manufacture (including use of membrane bioreactors).

2394 REDDY, VP; KHAN, MMH; PURUSHOTHAMAN, V. 1993. **Characterization of plasmid DNA in wild strains of lactococci isolated from raw milk.** *Milchwissenschaft*, 48: 8, 446-449.

2395 SINGHAL, RS; SAMANT, SK; GUPTE, RK. 1990. **Biotechnology in dairy industry.** *Indian Dairyman*, 42: 9, 372-380; 68 ref.

Recent applications of biotechnology within the dairy industry are reviewed under the headings: rennet substitutes; lactose degradation; use of biological systems for the preservation of milk and milk products (lysozyme, lactoperoxidase, lactoferrin); use of liposomes in the dairy industry; accelerated ripening of cheese; production of dairy flavours; dairy starter cultures; casein modification for altering the behaviour of milk during processing; and removal of cooked flavour in processed milk.

2396 THOMPSON, DK; MATHUR, BN. 1991. **Current status of biotechnological application in dairy industry.** *Indian Dairyman*, 43: 1, 9-11; 9 ref.

A number of examples of applications of biotechnology in the dairy and food processing industry are examined. The section headings are: genetic manipulation; dairy applications; industrial products; byproduct conversion; dairy cultures; and regulatory aspects.

2397 VARADARAJ, MC; NAMBU DRIPAD, VKN. 1983. **Growth and production of thermostable deoxyribonuclease and enterotoxin by *Staphylococcus aureus* in milk.** *Milchwissenschaft*, 38: 1, 23-26.

Fourteen enterotoxin-producing wild strains of *Staphylococcus aureus* (isolated from khoa) and 5 standard enterotoxin-producing *S. aureus* strains grew well in cows' raw whole milk (with low bacterial counts) or in sterilized skim milk. An inoculum giving 106 c.f.u./ml milk was used and incubation was at 37°C for up to 24 h. Production of thermostable DNAase was greater in sterilized milk than in raw milk. Enterotoxins were produced by all but 1 wild strain after 24 h in sterilized milk; in raw milk only 8 of the wild strains and none of the standard strains produced their respective enterotoxins.

SERICULTURE

Bombyx mori

2398 GEETHABALI; CHANDRASHEKAR, PM. 1989. **Glycerol formation in silkworm eggs.** *Proceedings of the Indian Academy of Sciences, Animal Sciences*, 98: 3, 187-191; 12 ref.

In a laboratory study, the temporal pattern of glycerol accumulation was examined during the early diapause period in eggs of *Bombyx mori*. Studies on the activities of 2 enzymes, NADP-dependent glycerol dehydrogenase and NAD-dependent glycerol phosphate dehydrogenase, showed that the latter may be more important than the former in the production of glycerol during diapause. It is concluded that the activity of the former may play a role in embryonic development.

2399 KRISHNAMURTHY, NB; RAMESH, SR; RAJASEKARASETTY, MR. 1984. **Developmental profiles in the isozymes of alpha and beta-esterases in the embryogenesis of silkworm *Bombyx mori*.** *Current Science*, 53: 5, 281-284; 4 ref.

Electrophoretic analysis of the eggs of *Bombyx mori* in the laboratory in India revealed a total of 12 bands for both alpha-esterases and beta-esterases in different stages of embryogenesis, and the number of isoenzymes and their relative concentrations was found to be different in all the 8 stages analysed. These results indicate that the various isoenzymes are synthesized, in varying amounts, at different stages of embryonic development, and show subtle differences in the expression of different genes in the same race of *B. mori* during development.

2400 LAKSHMI, SKB; RAMAIAH, TR. 1984. **Partial purification of prostaglandin synthetase from**

silkmoth *Bombyx mori* L. *Insect Biochemistry*, 14: 6, 725-728; 12 ref.

Prostaglandin synthase was isolated and purified from the post mitochondrial supernatant of the testis of males of *Bombyx mori*. A 3-fold purification was achieved compared to that of post mitochondrial supernatant. The partially purified enzyme converted arachidonic acid to PGE₂ in vitro in the presence of haemin and hydroquinone.

2401 MATHAVAN, S. 1983. **Effect of X-ray irradiation on developing eggs of the silkworm.** *Experientia*, 39: 9, 1037-1039; 9 ref.

Eggs of *Bombyx mori* were exposed in the laboratory in India to X-ray irradiation at different times after laying, and the changes in fertilisation, hatch and mortality of the eggs were observed. The percentages of fertilisation and hatch increased with increasing age of the eggs. Statistical analysis of the data showed that the observed changes were age-dependent.

2402 NIRANJANAKUMARI, S; GOPINATHAN, KP. 1992. **DNA polymerase-delta from the silk glands of *Bombyx mori*.** *Journal of Biological Chemistry*, 267: 25, 17531-17539.

The silk gland of *Bombyx mori* is a terminally differentiated tissue in which DNA replication continues without cell or nuclear division during larval development. DNA polymerase-delta activity increases in the posterior and middle silk glands during the development period, reaching maximal levels in the middle of the fifth instar larvae. The enzyme has been purified to homogeneity by a series of column chromatographic and affinity purification steps. It is a multimer comprised of three heterogeneous subunits, Mr 170,000, 70,000, and 42,000. An auxiliary protein from *B. mori* silk glands, analogous to the proliferating cell nuclear antigen, enhances the processivity of the enzyme and stimulates catalytic activity by 3-fold. This auxiliary protein has also been purified to homogeneity. It is a dimer comprised of a single type Mr 40,000 subunit. Polymerase-delta possesses an intrinsic 3' leads to 5' exonuclease activity which participates in proofreading by mismatch repair during DNA synthesis and is devoid of any primase activity. DNA polymerase-delta activity could be further distinguished from polymerase-alpha from the same tissue based on its sensitivity to various inhibitors and polyclonal antibodies to the individual enzymes. Like DNA polymerase-alpha, polymerase-delta is also tightly associated with the nuclear matrix. The polymerase alpha-primase complex could be readily separated from polymerase-delta (exonuclease) in the purification

protocol adopted. DNA polymerase-delta from *B. mori* silk glands resembles the mammalian delta-polymerases. Considering that both DNA polymerase-delta and -alpha are present in nearly equal amounts in this highly replicative tissue and their close association with the nuclear matrix, the involvement of both the enzymes in the chromosomal endoreplication process in *B. mori* is strongly implicated.

Mulberries (*Morus*)

2403 BAPAT, VA; RAO, PS. 1990. **In vivo growth of encapsulated axillary buds of mulberry (*Morus indica* L.).** *Plant Cell, Tissue and Organ Culture*, 20: 1, 69-70; 4 ref.

Axillary buds excised from shoot cultures were encapsulated in an alginate matrix containing one of the fungicides carbendazim, benomyl or bavastin at 50 or 100 mg/litre. After sowing on sterile soil, buds showed signs of growth 3 to 4 days later. The highest proportion of plant formation (63%) occurred when carbendazim was used in the encapsulation matrix.

2404 HOSSAIN, M; RAHMAN, SM; ZAMAN, A; JOARDER, OI; ISLAM, R. 1992. **Micropropagation of *Morus laevigata* Wall. from mature trees.** *Plant Cell Reports*, 11: 10, 522-524; 11 ref.

Multiple shoots were obtained from nodal explants, from a 10-year-old tree, on MS medium supplemented with different concentrations (0.5-5.0 mg) of benzyladenine (BA)/litre. Nodal segments taken from in vitro proliferated shoots gave further multiple shoots when cultured on the same basal medium containing 2.5 mg BA/litre. Repeated subculture resulted in rapid shoot multiplication at the average rate of 6-fold per subculture. In vitro raised shoots rooted on MS medium containing 0.1 mg each of IBA and NAA/l. Regenerated plantlets were successfully established in soil under field conditions after a few days of indoor acclimatization.

2405 ISLAM, R; JOARDER, OI; HOSSAIN, M; ZAMAN, A; BARMAN, AC. 1993. **Clonal propagation of *Morus alba* L. cv. SI from nodal explants of mature trees: maintenance of proliferating cultures.** *Sericologia*, 33: 2

2406 ISLAM, R; HOSSAIN, M; BARMAN, AC; ZAMAN, A; JOARDER, OI; HOSSAIN, ABM BAIZEED. 1992. **Effect of growth regulators on in vitro challogenesis in *Morus laevigata* Wall.** *Bull Sericult. Res.* 3: 55-58.

- 2407 ISLAM, R; ZAMAN, A; JOARDER, OI. 1992. Effects of different levels of sucrose on in vitro growth and development of mulberry microshoot. *Bangladesh Silk*, 3: 73-75.
- 2408 ISLAM, R; HOSSAIN, MM; BARI, MA. 1991. Evaluation of nitrogen fertilizer on leaf yield of mulberry. *J. Asiatic Soc. Bangladesh*, 17: 31-35.
- 2409 ISLAM, R; ZAMAN, A; HOSSAIN, M; JOARDER, N; BARMAN, AC. 1993. in vitro propagation of mulberry (*Morus alba* L.); effects of cytokinin types and tyrosine. *Bull. Sericult. Res.* 4: 6-9.
- 2410 ISLAM, R; ZAMAN, A; JOARDER, OI; BARMAN, AC. 1993. In vitro propagation as an aid for cloning of *Morus laevigata* Wall. *Plant Cell, Tissue and Organ Culture*, 33: 3, 339-341.
- 2411 JAIN, AK; DANDIN, SB; SENGUPTA, K. 1990. In vitro propagation through axillary bud multiplication in different mulberry genotypes. *Plant Cell Reports*, 8: 12, 737-740; 11 ref.
Axillary buds from 5 mulberry genotypes (4 species) were cultured on modified MS basal medium. A total of 30 media combinations were tested. The response of axillary buds and the requirement for growth regulators varied with genotype. Shoot induction in *Morus indica* was best with 0.25-0.5 mg BAP [benzyladenine] and with 0.5-1.0 mg GA3/litre in *M. alba* and *M. rotundifolia*. The *M. bombycis* cultivars Schimanochi and Mizusawa developed healthy shoots upon addition of 2,4-D at 0.5-1.0 mg and BAP at 0.5-2.0 mg/litre, respectively. IBA at 0.5 mg/litre, together with cytokinin/auxin/gibberellin, promoted root induction. Shoots developed from the axillary buds were further multiplied as nodal explants. MS basal medium supplemented with 0.5 mg IBA/litre and LS vitamins was found best for the production of healthy plantlets in all genotypes. On average, 89% survival was observed on transferring the plantlets to soil.
- 2412 JAIN, AK; DATTA, RK. 1992. Shoot organogenesis and plant regeneration in mulberry (*Morus bombycis* Koidz): factors influencing morphogenetic potential in callus cultures. *Plant Cell, Tissue and Organ Culture*, 29: 1, 43-50; 18 ref.
Regeneration of multiple shoots via callus induction and organogenesis was achieved. Pre-soaked internodal explants in 4.4-8.9 μ M benzyladenine (BA) formed callus on Linsmaier and Skoog's medium containing 2,4-D (9.05 μ M), NAA (2.85 μ M) and BA (2.2 μ M). Explants soaked for 48-72 h in low levels of BA produced loose and nodular callus that showed regeneration ability. Calluses developed adventitious shoot buds within 3-4 weeks on medium containing BA (8.9 μ M). Fifteen-week-old calluses developed fewer shoot buds than 5-week-old calluses, indicating a decrease in morphogenetic potential with increasing duration of callus cultures. Semi-thin section microscopy was used to evaluate incapability of sustained regeneration. Development of normal shoot bud primordia, due to sub-surface reorganization, was high in young calluses. Decline in the frequency of shoot bud primordia formation with callus ageing is due to reduced cell division activity in epidermal as well as sub-epidermal layers.
- 2413 MHATRE, M; BAPAT, VA; RAO, PS. 1985. Regeneration of plants from the culture of leaves and axillary buds in mulberry (*Morus indica* L.). *Plant Cell Reports*, 4: 2, 78-80; 8 ref.
Stem segments, axillary buds and leaves excised from established shoot cultures were soaked in Murashige and Skoog liquid medium containing BA (0.5, 1, 2 mg/litre) and were cultured subsequently on semi-solid medium of the same composition. Numerous shoot buds differentiated from leaf and axillary buds but stem segments were unresponsive. On isolation and culture the shoot buds developed into plantlets. Callus tissues which developed at the base of the leaf explant upon subculture also differentiated numerous shoot buds.
- 2414 NARAYAN, P; CHAKRABORTY, SP; SENGUPTA, K. 1992. Anther culture in *Morus alba* L. var. *SI*. *Cell and Chromosome Research*, 15: 1.
- 2415 NARAYAN, P; CHAKRABORTY, SP; SENGUPTA, K. 1993. Flower induction in long term culture from internodal callus in *M. alba* L. *Sericologia*, 33: 4.
- 2416 NARAYAN, P; CHAKRABORTY, SP; SENGUPTA, K. 1991. High frequency regeneration of plant in *Morus latifolia* L. in Gosheoerami. *Journal of Tree Science*, 10: 1.
- 2417 NARAYAN, PRATAP; CHAKRABORTY, S; RAO, GS. 1989. Regeneration of plantlets from the callus of stem segments of mature plants of *Morus alba* L. *Proceedings of the Indian National Science Academy. Part B, Biological Sciences*, 55: 5-6, 469-472; 12 ref.
Callus cultures were raised from internodal segments of mature plants of *Morus alba* on Murashige and Skoog's medium supplemented with 1.0 mg/litre 2,4-D and 0.5

mg/litre BAP [benzyladenine]. Shoots were regenerated when the induced calli were transferred to medium containing 0.5 to 3.0 mg/litre BAP. Callus derived shoots produced roots and developed into plantlets when transferred to medium supplemented with 0.5 mg/litre NAA. Use of callus culture as a method of propagating *M. alba* for producing silkworm feed is recommended since the use of cuttings is restricted seasonally and produces poor results. The results given here also demonstrate the potential of the method for inducing morphological variation for tree improvement studies.

2418 PATEL, GK; BAPAT, VA; RAO, PS. 1983. **In vitro culture of organ explants of *Morus indica*: plant regeneration and fruit formation in axillary bud culture.** *Zeitschrift fur Pflanzenphysiologie*, 111: 5, 465-468; 4 ref.

Axillary buds, stem segments, leaf discs, and petiole explants from mature trees of mulberry were cultured on a modified Murashige and Skoog basal medium supplemented with various growth regulators. Responses to growth regulators are tabulated. Callus formation resulted from stem, leaf and petiole explants whereas in cultures of axillary buds regeneration of shoots was observed. The shoots developed into complete plants which flowered and set fruit.

2419 RAGHUNATH, MK; CHAKRABORTY, SP; NARAYAN, P; ROY, BN; SEN, SK. 1992. **Micropropagation of superior hybrids through axillary bud culture in mulberry (*Morus L.*).** *Cell & Chromosome Research*, 15: 1.

2420 ROYCHOUDHURY, N; BASU, R; SHAM-SUDDIN, M; SEN, SK. 1994. **Raising of silkworm *Bombyx mori L.* on artificial diet after chawki rearing on mulberry leaf.** *Sericologia*, 34(1).

2421 SRIVASTAVA, BL; TANDON, S. 1985. **Adventive embryony in *Morus species* (mulberry).** *Phytomorphology*, 35: 3/4, 181-182; 5 ref.

Adventitious embryony was recorded in *M. laevigata* and *M. indica* but not in *M. alba* or *M. australis*. Adventitious embryos developed from the cells of the ovary wall and the nucellus, or more rarely from the micropylar region. The phenomenon occurred under open and controlled cross pollinations, and also, but less frequently, in unpollinated flowers. Most adventitious embryos degenerated between the 4- and 8-celled stages.

2422 TEWARY, PK; GUPTA, BK; RAO, GS. 1989. **In vitro studies on the growth rate of callus of**

mulberry (*Morus alba L.*). *Indian Journal of Forestry*, 12: 1, 34-35; 7 ref.

Callus of *Morus alba* (S1 strain) was initiated and maintained from leaf explants first soaked in Murashige and Skoog liquid medium supplemented with BAP [benzyladenine], kinetin and 2,4-D, and subsequently cultured on semi-solid medium of the same composition. Browning of the callus occurred after a certain age. BAP + 2,4-D were the most suitable additions for long-term growth (9 months or more). Growth rate increased with time in culture, reaching a maximum at about 4 months.

2423 TEWARY, PK; SUBBA RAO, G. 1990. **Multiple shoot formation through shoot apex culture of mulberry.** *Indian Journal of Forestry*, 13: 2.

2424 TEWARY, PK; LAKSHMISITA, G. 1992. **Protoplast isolation, purification and culture in mulberry (*Morus spp.*).** *Sericologia*, 32: 4, 651-662.

2425 VERMA, RC; SARKAR, A; DAS, BC. 1984. **Cytomixis in mulberry.** *Current Science*, 53: 23, 1258-1260; 13 ref.

A triploid plant, formed by crossing an induced tetraploid (*Morus indica* X *M. alba* cv. *Mandalaya*) with a diploid, exhibited cytomixis during all stages of meiosis. The frequency was highest at anaphase II, and most cases of cytomixis involved up to 4 cells. Other abnormalities, such as multinucleate cells, were observed.

2426 YADAV, U; LAL, M; JAISWAL, VS. 1990. **Micropropagation of *Morus nigra L.* from shoot tip and nodal explants of mature trees.** *Scientia Horticulturae*, 44: 1-2, 61-67; 17 ref.

Shoot tip and nodal explants from a 12-year-old mulberry tree were cultured on MS medium supplemented with 0.1-10 mg BA/litre or 0.1-10 mg kinetin/litre. Shoot proliferation was greatest with 1.0 mg BA/litre for both types of explant. Shoots were transferred to MS medium supplemented with 0.025-5.0 mg IBA, IAA or NAA/litre. The average number of roots produced per shoot after 4 weeks of culture was greatest with 0.25 mg IBA/litre. Rooted plants were successfully transferred (75% survival) to the field after pot culture at the 3- to 4-node stage at high RH for 3-5 d.

2427 ZAMAN, A; ISLAM, R; HOSSAIN, M; JOARDER, OI; AHAD, A; BARMAN, AC. 1992. **Clonal propagation through in vitro shoot proliferation of nodal explants of seven mulberry genotypes.** *Plant Tissue Culture*, 2: 2, 71-74.

Nodal explants from seven genotypes of two mulberry species were induced to form multiple shoots on MS medium with three different concentrations of benzyladenine (BA). BSRM-19 was found to be highly responsive genotype for in vitro shoot and root proliferation. Regenerated plants were successfully established in soil after acclimatization.

2428 ZAMAN, A; ISLAM, R.; JOARDER, OI; BARMAN, AC. 1993. **Clonal propagation of mulberry from mature field grown trees.** *International Plant Tissue Culture Conference.* (Dhaka Univ., Dept. of Botany: December 19-21).

2429 ZAMAN, A; ISLAM, R; ISLAM, S; BARMAN, AC; JOARDER, OI. 1994. **Effects of aminoacids on cloning of mulberry microshoots: observation, analysis and consequences.** *Bull. Sericult. Res.* V.5.

2430 ZAMAN, A; ISLAM, R; JOARDER, OI; BARMAN, AC. 1992. **Effects of different sugars on in vitro shoot proliferation of *Morus alba* cv SI.** *Bull. Sericult. Res.* 3: 14-17.

2431 ZAMAN, A; ISLAM, R; BARMAN, AC; JOARDER, OI. 1992. **Effects of pH on in vitro rooting of mulberry (*M. alba*).** *Bang. Silk,* 3:76-78.

2432 ZAMAN, A; ISLAM, R; BARMAN, AC; AHAD, A; QUADER, MA; JOARDER, OI. 1993. **Effects of sucrose, pH and temperature on the vitro rooting of mulberry (*Morus alba* L. cv SI) microshoots.** *Bull Sericult. Res.* 4: 10-13.

2433 ZAMAN, A; ISLAM, R; HOSSAIN, M; HOSSAIN, ABM BAIZEED; BARMAN, AC; JOARDER, N. 1992. **In vitro clonal propagation of mulberry (*Morus alba* cv SI) Effects of agar and pH on shoot proliferation.** *Bull. Sericult. Res.* 3: 51-54.

2434 ZAMAN, A; ISLAM, R; AHAD, A; ISLAM, S; BARMAN, AC; JOARDER, OI. 1994. **In vitro technique as an efficient tool for the micropropagation of mulberry : microbial interruption in different seasons.** *Bull. Sericult. Res.* V.5.

2435 ZAMAN, A; ISLAM, R; HOSSAIN, M; JOARDER, OI; AHAD, A; BARI, MA. 1993. **Morphogenetic behavior of mulberry (*Morus alba* C776) seedling shoot tip explants.** *J. Bioscience,* 1: 49-53.

2436 ZAMAN, A; ISLAM, R; HOSSAIN, M; BARI, MA; JOARDER, OI. 1993. **Plant regeneration and seedless fruit formation in nodal explant cultures of *Morus alba* L. Cv. SI.** *Sericologia,* 33: 2, 313-322.

2437 ZAMAN, MA; RAHMAN, SM; JOARDER, N; ISLAM, R. 1991. **Mass propagation of mulberry (*Morus alba* L.) through axillary bud culture.** *Plant Tissue Culture,* 1: 75-78.

AQUACULTURE

2438 HOSSAIN, MS. 1992. **Tissue localization of *Aeromonas salmonicida* strains following bath challenge in Atlantic salmon, *Salmo salar* L..** *Bangladesh Journal of Microbiology,* 9: 2, 67-73.

The localization of nine *Aeromonas* strains within the tissues of atlantic salmon parr, *Salmo salar*, was determined following bath challenge. Of 6 tested, kidney was the site where bacteria were largely localized. The reference virulent strain FCS was found to localize in very high numbers ($1.48 \times 10(1)$ cfu/g issue) in the kidney. Other than FCS, a virulent strain B901044 (3) was found to localize in considerable numbers ($3.9 \times 10(2)$ cfu/g tissue) in the spleen. There was no apparent difference in the localization pattern of the other *A. salmonicida* strains.

2439 JANA, BB; SARKAR, G; KUNDU, G. 1985. **Pattern of physicochemical changes in the water during hatching of Indian carp eggs in a Chinese hatchery.** *Aquaculture,* 47: 1, 89-96; 17 ref.

Physicochemical changes in the water were monitored at different stages of embryo and larval development of Indian carp (*Cirrhinus mrigala*) eggs in a Chinese hatchery system with 75-85% hatching success. At a water temp. of 29.3°C, mass hatching of the embryos started at about 11-12 h after fertilization, and was completed within 4 h. The amount of dissolved oxygen and chemical oxygen demand ranged between 4.8 and 9.63 mg/litre and between 16.5 and 185.0 mg/litre resp. A marked rise in the concentration of bicarbonate and total hardness of the water after egg transfer into hatching tanks was perhaps due to liberation of calcium and magnesium ions from the egg mass. A sharp decline in phosphate content during hatching was associated with the building of bones, while the ammonia level was greatly increased due to a high rate of nitrogenous excretion during hatching.