Chapter – 3
DUMPS is an inherited disorder in Holstein cattle, a condition analogous to human hereditary orotic aciduria. During lactation, heterozygous cows exhibit orotic aciduria and orotic acidaemia (Robinson et al., 1984). The level of this metabolite is also elevated in milk when an animal is a carrier. Longevity is not compromised and growth is normal in heterozygous cattle for UMP synthase deficiency (Shanks et al., 1987). However, heterozygous cows have a longer calving interval than normal (Shank et al., 1986). Biochemical study of the enzyme from normal and heterozygous cattle has revealed that the protein produced by the mutant allele is present in haemolysates but at a lower level than the normal protein (Harden and Robinson, 1987). The enzyme, Uridine Monophosphate Synthase is found in all body cells. Cattle have at least 20,000 different enzymes that are involved with growth, movement, reproduction, lactation and other biological processes. Defects in any of these enzymes would cause moderate to severe problems. Over 200 inherited enzyme deficiencies are known in human and 7 in cattle with DUMPS being the most recently discovered disease (Shanks et al., 1987). The UMP synthase is a key enzyme in the last step of pyrimidine nucleotide synthesis which converts orotate to Uridine-5'-monophosphate (UMP). The gene for UMPS is located on human chromosome 3 (Patterson et al, 1983) and on bovine chromosome 1 (Friedle and Rottmann 1994;
Ryan et al., 1994; Barendse et al., 1993). The mutation (C→T) occurs at codon 405 resulting loss of Ava I site in the gene, and premature stop of codon of the protein (Schwenger et al., 1993). Defective enzyme would be impaired in function, with the result the pyrimidine nucleotide synthesis will stop. This will ultimately cease the cell division and lead to embryonic death.

As embryos homozygous for DUMPS do not survive to birth, rather die at early in gestation, no homozygous recessive animal was detected so far. The embryos appear to be aborted or reabsorbed approximately 40 days after conception, leading to repeat breeding problems (Shanks and Robinson, 1989; Robinson et al., 1993). As described by Schwenger et al. (1994), the amplified 105 bp upon digestion by Ava I, to detect point mutation in a gene coding for Uridine Monophosphate Synthase, yielded three bands of 53 bp, 36 bp and 19 bp respectively for normal animals. None of animal showed four bands of 108 bp, 53 bp, 36 bp and 19 bp, indicating no animal was found to be carrier for the disease (Figure 22). The electrophoretogram of Ava I digested PCR product of normal animal is given in figure 23. Deficiency of Uridine Monophosphate Synthase is a monogenic autosomal recessive disorder in cattle, resulting in early embryonic death of homozygous offspring.
Fewer cases were reported from a few countries except North America. In late 1987, the condition was declared an undesirable enzyme defect by the Holstein Association of America (HAA) and testing programmes were initiated, whereby heterozygotes were detected by half normal activity of erythrocyte UMP synthase (Robinson et al., 1993). From 1988 to 1991, 585 were identified as carriers out of 3461 animals screened for DUMPS. During the same period 1226 animals were tested in Europe with 414 shown to be carrier, higher percentage of carriers. Thus, by 1992, over 1000 DUMPS carriers have been identified. However, BLAD was 10 times more prevalent in US Holstein cattle than DUMPS (Shuster et al., 1992). Two carriers were found among 314 AI bulls, 682 bull mothers and 155 young bulls in Hungary (Fesus et al., 1999). Mutations in UMPS gene were also identified in 1.79% bulls and 0.96% cows in Argentina (Poli et al., 1996). Similarly two out of 1468 HF cattle were found carrier for DUMPS in Taiwan (Lin et al., 2001). However, DUMPS disorder in HF cattle is lethal during early embryonic period. On the basis of a modest number of animals examined, Jones et al. (1986) reported effects of age and sex on erythrocyte UMP activity; with newborn having 80% more than mature animals. With regards to sex males had 10% more activity than females. It is difficult to
observe homozygous recessive genotype for DUMPS, however, Shanks et al. (1992) identified the homozygous recessive genotype for DUMPS in 35-days bovine embryos. In Taiwan also recently reported two carriers out of 1468 HF animals screened for DUMPS (Lin et al., 2001). Whereas, no incidence of DUMPS carriers was observed in 2209 dairy cattle of the Polish Holstein breed reported recently (Kaminski et al., 2005). This is similar to our observation wherein we have screened 1250 including 976 cattle and 274 buffaloes (Patel et al., 2006), indicating that Indian dairy animals are free from DUMPS. Hence, it has been recommended discontinuing DUMPS test in Indian dairy animals. But whenever there is an import of HF animals, their semen doses and embryos ought to be screened before use in our ongoing breeding programmes to prevent the risk of prevalence of this genetic disease in our cattle and buffalo population.
Figure 22: Incidence of DUMPS in cattle and buffaloes
Figure 23: Electrophoretogram of Ava I digested PCR product generated by amplification of genomic DNA using DUMPS specific primers. Lane # 1: 25 bp DNA hyper ladder-V (Bioline, USA), lane # 2-9: 53, 36 and 19 bp bands respectively of normal animals and lane # 10: PCR product of 108 bp.