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Oxytocin, Functions, Uses and Abuses: A Brief Review

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Abstract

Oxytocin a peptide hormone has the distinction of being the first among the peptide hormones to be sequenced and biochemically synthesized. Oxytocin is secreted from neural as well as non-neural sources inside the body. Among the neural sources supra-optic and paraventricular nuclei of the brain are major sources of secretion, the arcuate nucleus being a minor source. There are many non-neural sources from which synthesis of Oxytocin has been reported. The important ones include interstitial cells of Leydig in testis, epididymis, prostate glands, corpus luteum inside ovary, uterus, oviduct, placenta and adrenal glands. Oxytocin directly acts on the smooth muscle cells and causes muscle contraction. Indirectly it stimulates synthesis of $PGF_2\alpha$ inside the female genital tract. As such the Oxytocin is involved in a wide spectrum of activities from milk letdown, parturition, penile erection and ejaculation to social, sexual and maternal behavior. Because of the spectrum of its functions it has since been used therapeutically for conditions like facilitating parturition in uterine inertia, prevent bleeding after parturition and abortion, management of incomplete abortion, milk letdown, retention of placenta etc., although the success has not been predictable. However, Oxytocin is also being misused under the false impression that its use in dairy animals increases the milk yield. Oxytocin abuse is also rampant in fruits and vegetables. This article is an attempt to explore the body of knowledge with respect to functions, uses and most importantly the abuses of this wonderful hormone.

Keywords: Oxytocin, functions, uses, abuses

Introduction to Oxytocin

Oxytocin is a neurohypophysial hormone secreted from meganocellular

neurosecretory cells in supraoptic and paraventricular nuclei of the hypothalamus and stored in posterior pituitary until its release into blood stream. It is also known as α-Hypophamine. Oxytocin is a peptide hormone which consists of nine aminoacids (nanopeptide), with a disulfide bridge between cystine residues 1 and 6. There is a neutral amino acid leucine at position 8 as compared to basic aminoacid (arginine) at the same position in case of vasopressin also known as anti diuretic hormone (ADH). Isoleucine at position 3 is necessary for stimulation of Oxytocin receptors. This hormone has a distinction of being first among polypeptide hormones to be sequenced and synthesized biochemically (Vincent du Vigneaud *et al.* 1953).

Oxytocin inside the neurohypophysis is synthesized as part of a prohormone system that includes Oxytocin and Neurophysin-I. This prohormone is called Oxytocin-Neurophysin-I complex (Zimmerman *et al*. 1974; Robinson, 1987). The prohormone is synthesized in magnocellular neurons of neurohypophysis (supraoptic and paraventricular nuclei) packaged in neurosecretory granules and transported to axon terminals located in posterior pituitary (Land *et al*., 1983; Robinson, 1987). This complex is stored inside Herring bodies at axon terminals until there release into blood stream (Renaud& Bourque, 1991). In case of horse it has been suggested that arcuate nucleus of the hypothalamus may produce this hormone as well.

Secretion of Oxytocin from neurosecretory nerve endings is regulated by electrical activity of the Oxytocin cells in the hypothalamus. Upon receiving the necessary nerve inputs the action potential is propagated down the axons to the nerve endings, where the Oxytocin containing vesicles liberate the hormone by exocytosis. Before the release of Oxytocin, it needs to be cleaved off from the large Neurophysin-I molecule. This is achieved by a progressive process via a series of enzymes. The last hydrolysis, which releases the active Oxytocin nanopeptide, is catalyzed by the enzyme peptidylglycine α-amidating monooxygenase (Sheldrick and Flint, 1989).

In addition to neural synthesis, Oxytocin is also produced by non-neural sources. The first indication of local Oxytocin synthesis within the reproductive tract was obtained by Nicholson *et al.* (1984). Using radio immunoassay (RIA) and High Performance Liquid Chromatography (HPLC) an Oxytocin like peptide was detected in both human and rat testes. The development of techniques to identify Oxytocin mRNA transcripts and Oxytocin receptors has since provided conclusive evidence to support local synthesis of Oxytocin within reproductive tract. In case of females Oxytocin is not only synthesized in reproductive tract organs including oviduct and uterus, but is also synthesized

in corpus luteum in case of buffalo and cow (Wathes *et al.* 1983) and probably mare. The local production of this hormone outside the neural tissue suggests its paracrine role near the sites of production (Gimpl and Fahrenholz, 2001). The other reported sites of non-neural Oxytocin synthesis include epididymis (Filippi *et al.* 2002; Assinder *et al.* 2000) interstitial cells of Leydig (Guldenaar and Pickering, 1985), prostrate (Whittington *et al.* 2004), adrenal medulla (Ang and Jenkins, 1984), placenta (Fields *et al.* 1983), retina (Gauquelin *et al.* 1983), thymus (Geenen *et al.* 1986), pancreas (Amico *et al.* 1988), etc.

Oxytocin receptors have been identified and localized within the tissues of reproductive tract in both males and females, and is thus accepted as a key paracrine regulator in both sexes.

Mechanism of action of Oxytocin

Oxytocin acts by means of specific group of proteins present on the membrane of the responding cells. These are the Oxytocin receptors. The Oxytocin receptor is a seven transmembrane –domain polypeptide, belonging to the Rhodopsin-type class-I G-protein coupled receptor family, GPCR (Kimura *et al.* 1992). Classically Oxytocin receptors are coupled with Gq subtype of G-proteins that bind to GTP and stimulate the activity of Phospholipase-C enzyme (Ku *et al.* 1995). The binding of Oxytocin to its receptor gives rise to a chain of events that finally activate Phospholipase-C enzyme. This enzyme acts to generate ITP (inositol triphosphate) and DAG (1, 2-diacyl glycerol). ITP triggers release of intracellular Ca^{++}, which in turn triggers a variety of cellular events (Gimpl and Fahrenholz, 2001).

In smooth muscles such as those in myometrium, the Ca^{++} binding protein called Calmodulin binds to Ca^{++} to generate Ca^{++}-Calmodulin complex. This complex then activates Myosin Light Chain Kinase (MLCK) enzyme to initiate smooth muscle contraction (Sanborn *et al.* 1998). The indirect action of Oxytocin is due to its stimulatory action on synthesis of PGF2α (Fuchs *et al.* 1981).

Functions of Oxytocin

Oxytocin has traditionally been recognized as a "female" hormone so much so that the name itself has been derived from Greek word meaning "quick birth". With the spectrum of knowledge widening day by day a large number of functions have been ascribed to this hormone. Based upon the diverse functions this hormone carries out, two systems have been recognized; the central Oxytocin system and the peripheral Oxytocin system. The peripheral actions of Oxytocin mainly reflect secretion from pituitary gland. The

behavioral effects of this hormone are thought to reflect the secretion from centrally projecting Oxytocin neurons different from those that enter the posterior pituitary or which are collaterals from them (Ross *et al.* 2009). This belief is mainly because Oxytocin secreted from pituitary gland cannot re-enter brain owing to blood-brain barrier.

Peripheral actions of Oxytocin

a. *Letdown reflex – in lactating females*: Oxytocin acts at the mammary glands, causing milk to letdown into subareolar sinuses, from where it can be excreted. Sucking by the infant at the nipple generates an impulse that is transmitted to hypothalamus by Spinal nerves. The stimulation causes neurons that make Oxytocin to fire action potentials in intermittent bursts; these bursts result in the secretion of pulses of Oxytocin from the neurosecretory nerve terminals of the pituitary gland. Oxytocin has direct effect on the myoepithelial cells surrounding the milk cistern. It makes these cells to contract thus propelling milk towards exterior. Oxytocin is also believed to affect milking by an indirect effect through prolactin hormone (PRL). Oxytocin plays a part in Fergusson reflex in males (Thackare *et al.* 2006).

b. *Penile erection and ejaculation*: Penile erection is among the primer sexual responses and essential for successful reproduction. Regulation of penile erection has been explained by different neural and/or endocrine mechanisms. Oxytocin is one of the most potent agents known to induce penile erection in man (Thackare *et al.* 2006), though in rat nitric oxide (NO) has been observed to play the key role in this process (Argiolas, 1992). Oxytocin neurons within the paraventricular nucleus, that project into extra hypothalamic areas especially spinal cord are involved in this effect. Yangiomoto *et al.* (1996) demonstrated that electrical stimulation of the dorsal penile nerve and tactile stimulation of glans penis elicits a specific activation of 40-50% Oxytocinergic neurons in Paraventricular nucleus of the hypothalamus. This study suggests that somato-sensory information from penis is transmitted to hypothalamus through an Oxytocin based reflex arc similar to milk letdown reflex seen in females. In several species including human males, a pulse of Oxytocin of hypothalamic origin is associated with ejaculation (Ogawa *et al.* 1980; Carmichael *et al.* 1987; Murphy *et al.* 1987). Oxytocin has also been postulated to modulate contractility of male reproductive tract (seminiferous tubules, epididymis, prostate, and penis) to regulate sperm transport and maturation (Thackare *et al.* 2006) and spermiation (Harris and Nicholson, 1998a).

c. *Parturition and uterine involution*: Oxytocin aids cervical dilation before birth and causes uterine contractions during the second and third stages of labor. Oxytocin is one of the most potent uterotonic agents and is often clinically used to induce labour. Oxytocin acts on an estrogen primed uterus at the time of parturition. However, despite the use of very sensitive assays, many researchers have failed to realize an increase in Oxytocin concentration during early labor (Mitchell *et al.* 1998) questioning the physiological role of this hormone in initiation of labor (Chard, 1989; Nishimore *et al.* 1996). Also, in knockout mice (lacking the Oxytocin receptor), normal reproductive behavior and parturition has been reported (Takayanagi *et al.* 2005). Oxytocin release during sucking by the infant causes mild but often painful contractions during the first few weeks of lactation, which serves to assist uterine involution. However Oxytocin is essential for milk ejaculation (Nishimore *et al.* 1996).

d. *Modulation of testicular steroidogenesis*: The synthesis of Oxytocin by Leydig cells together with presence of Oxytocin receptors on this cell type suggests that this hormone may have role in modulation of testicular steroidogenesis. Adashiand Hsueh (1981) showed that Oxytocin inhibits gonadotrophin-stimulated androgen biosynthesis in isolated rat Leydig cells through testicular recognition sites similar to those mediating the pressor actions of neurohypophysial hormones. The data collected by Nicholson *et al.* (1991) suggests that Oxytocin could influence the conversion of testosterone into dihydrotestosterone.

e. *Cellular proliferation*: The effects of Oxytocin on cellular proliferation seem to be tissue specific. This hormone has also been shown to modulate mitotic activity in various organs including bone osteoblasts (Petersson *et al.* 2002), breasts (Bussolati *et al.* 1996), ovary (Morita *et al.* 2004) and small cell lung cancer cells (Pequeux *et al.* 2002). Whereas in osteoblasts and small cell carcinoma of lungs, Oxytocin stimulates growth (Pequeux *et al.* 2002), in human breast cancer cells (Cassoni *et al.* 1994) and ovarian carcinoma cells (Morita *et al.* 2004) Oxytocin inhibits cellular proliferation. Oxytocin has been postulated to regulate growth of prostate (Nicholson, 1996), and be involved in the pathogenesis of prostate disorders.

f. *Reproductive role*: The relationship between Oxytocin and sexual response is unclear. Increase in plasma Oxytocin at orgasm has been reported in both men and women (Carmichael *et al.* 1987 and 1994). It is speculated that Oxytocin's effects on muscle contractibility may facilitate sperm and egg transport (Carmichael *et al.* 1987). Anderson-Hunt *et al.* (1995) and Kruger *et al.* (2003) believed that increase in concentration of Oxytocin

during sexually aroused states could be in response to nipple/areola, genital, and/or genital tract stimulation. In contrast to the facilitatory role of Oxytocin on sexual behavior of male rats, in male Pririe Vole it causes an immediate cessation of all sexual activity that lasts for 24 hours (Mahalati *et al.* 1991). Oxytocin evokes feelings of contentment, reductions in anxiety, and feelings of calmness and security around the mate (Meyer-Dixie, 2007). Many studies have already shown a correlation of Oxytocin with human bonding, increases in trust, and decreases in fear. Marazziti *et al.* (2006) confirmed that there was a positive correlation between Oxytocin plasma levels and an anxiety scale measuring the adult romantic attachment. Thus this hormone is sometimes called "love hormone".

g. Due to its similarity to vasopressin, Oxytocin is believed to reduce the excretion of urine slightly and stimulate sodium excretion from the kidneys (natriuresis). In humans, high doses of Oxytocin can result in hyponatremia (Conrad *et al.* 1993; Huang *et al.* 1996). Oxytocin under certain circumstances indirectly inhibits release of adrenocorticotropic hormone and cortisol. In such situations, it may be considered an antagonist of vasopressin (Hartwig and Walenty, 1989).

h. In case of some rodent species Oxytocin and its receptors have been identified in heart and are believed to play a role in the embryonic development of the heart by promoting cardiomyocyte differentiation (Paquin *et al.* 2002; Jankowski *et al.* 2004). However, the absence of either Oxytocin or its receptor in knockout mice has not been reported to produce cardiac insufficiencies (Takayanagi *et al.* 2005).

i. Oxytocin may play a role in autism and may be an effective treatment for autism's repetitive and affiliative behaviors (Bartz and Hollander, 2008). More recently, intranasal administration of Oxytocin was found to increase emotion recognition in children diagnosed with autism (Guastella *et al.* 2010). As per Andaria *et al.* (2010) autistic patients after treatment with inhaled Oxytocin, exhibit more appropriate social behavior. While this research suggests some promise, further clinical trials of Oxytocin are required to demonstrate potential benefit and side effects in the treatment of autism. As such, researchers do not recommend use of Oxytocin as a treatment for autism outside of clinical trials. Nasally administered Oxytocin has also been reported to reduce fear, possibly by inhibiting the amygdala which is thought to be responsible for fear responses (Shamay-Tsoory, 2009). Oxytocin is also related with stress-related behavior, memory and learning.

Actions within the brain (central actions of Oxytocin)

Oxytocin secreted from the pituitary gland cannot re-enter the brain because of the blood-brain barrier. Instead the behavioral effects of Oxytocin are thought to reflect release from centrally projecting Oxytocin neurons, different from those that project to the pituitary gland, or which are collaterals from them (Ross *et al.* 2009). Oxytocin receptors are expressed by neurons in many parts of the brain and spinal cord, including the amygdala, ventromedial hypothalamus, septum, nucleus accumbens and brainstem.

a. *Sexual behavior*: Oxytocin injected into the cerebrospinal fluid causes spontaneous erections in rats (Gimpl and Fahrenholz, 2001), reflecting actions in the hypothalamus and spinal cord. Centrally administrated Oxytocin receptor antagonists can prevent non contact erections, which is a measure of sexual arousal. Arletti and Bartolini (1985) studied effect of Oxytocin on sexual behavior in female rats using Oxytocin antagonists and concluded that this hormone increased sexual receptivity in them.

b. *Social behavior*: Oxytocin has a role in social behaviors in many species, and so it seems likely that it also does in humans. Kuchinsks (2003) suggested that this hormone may play a role in the emotional bonding between humans and dogs. Oxytocin has been reported to mediate aggressive and affiliative behaviors in several species including rat (McCarthy, 1990), sheep (Kendrick *et al.* 1987) and human (Fanelli *et al.* 1999).

c. *Maternal behavior*: Female rats given Oxytocin antagonists after giving birth do not exhibit typical maternal behavior (Van Leengoed *et al.* 1987). However Kendrick (2004) reported a reciprocal event. As per him virgin female sheep show maternal behavior towards foreign lambs upon cerebrospinal fluid infusion of Oxytocin, which they would not do otherwise. Bick and Mary Dozier (2010) believe that Oxytocin is involved in the initiation of maternal behavior not its maintenance.

d. *Feeding and grooming*: Oxytocin acts as a "satiety hormone" in animals since both peripherally and centrally administered Oxytocin reduces feeding. Arletti *et al.* (1989) reported that Oxytocin reduces food consumption and the time spent eating. Slow infusion of Oxytocin in paraventricular nucleus of rats initiates self-grooming (Gimple and Fahrenholz, 2001).

e. *Tolerance and dependence to opioids*; According to studies conducted by Kovacs *et al.* (1998), Oxytocin inhibits the development of tolerance to various addictive drugs (opiates, cocaine and alcohol) and reduces withdrawal symptoms.

f. Preparing fetal neurons for delivery: Crossing the placenta, maternal Oxytocin reaches the fetal brain and induces a switch in the action of neurotransmitter GABA from excitatory to inhibitory on fetal cortical neurons. This silences the fetal brain for the period of delivery and reduces its vulnerability to hypoxic damage (Tyzio *et al.* 2006).

Current and future uses of Oxytocin

Oxytocin and its synthetic analogues are quite commonly used in human as well as veterinary medicine. In the human medicine, it is the drug of choice to induce rhythmic contractions of the uterus and augment uterine contractions during desultory labor. It is prescribed to control and prevent bleeding after childbirth and abortion. Oxytocin is also used for the induction of medical termination of pregnancy (MTP) and management of inevitable or incomplete abortion (Ijaz and Aleem, 2006). Equally important is its clinical use for promotion of milk ejection in lactating women, who experience difficulty in breast feeding and for treating cases of breast engorgement and mastitis.

In veterinary practice Oxytocin is used universally to induce letdown of milk and help expulsion of placenta after delivery. The hormone is also used to aid delivery in young animals when the female has been in labor for an extended period. Moreover, it is also helpful in the management of post parturient uterine prolapse. It is also employed frequently as an adjunct to antibiotic therapy for the treatment of metritis (Nafis *et al.* 2012a, 2102b). Oxytocin is routinely used to evacuate the uterine fluids during the treatment of uterine infections and associated endometritis. It has been found to be more effective in clearance of uterine fluids from mares than PGF2α and Cloprostenol (Nafis, 2011).

Oxytocin has been shown *in vitro* to improve spermiation and sperm transportin a number of animal models and may therefore improve the quality of semen present in an ejaculate (Thackare *et al.* 2006). Intravenous injections of 50 IU of Oxytocin increased the number of spermatozoa in the first ejaculates of electroejaculated Holstein bulls without altering the daily sperm production or other semen qualities. This effect of Oxytocin was suggested to be potentially advantageous in frozen semen programmes so that less frequent electroejaculation is needed or even a single ejaculation can be planned (Berdntson and Igboeli, 1988). From these animal studies Thackare *et al.* (2006) suggested that cases of oligospermia that are not related to hypogonadotrophic hypogonadism may benefit from Oxytocin administration. Carmichael *et al.* (1987) and Argiolas (1992), on the basis of their studies on role of Oxytocin in

penile erection and ejaculation suggested that Oxytocin could be used in the treatment of impotence and ejaculatory disorders.

Oxytocin has been postulated to regulate growth of prostate (Nicholson, 1996) and to be a potential therapeutic option in the treatment of benign prostatic hyperplasia. Loss of Oxytocin immunoreactivity with progression of prostatic malignancy (Thackare *et al.* 2006) suggests that it can be used as a marker for prostate cancer in humans.

Devonish *et al.* (1992) studied the effects of Oxytocin in sheep and concluded that Oxytocin administration in sheep not only aided in transcervical artificial insemination but also improved the conception rate in this species. They recorded a conception rate of 73% compared to 53% when hormone was not used. Thus Oxytocin may be used to realize intrauterine artificial insemination/ transcervical artificial insemination (TCAI) in sheep. Similar findings were also reported by Jones (1968).

Natzke and Schultz (1996) concluded that Oxytocin may have merit as an agent to remove the residual milk and udder debris, during the treatment of mastitis, as prior removal of these substances from the udder should enhance the local effect of antibiotics used during the treatment.

Of late much has been written about the beneficial effects of Oxytocin on autism, improving trust in relationships, dampening social anxieties, attractions between opposite sexes, but it remains to be seen that whether these claims pass the test of laboratory or not.

Abuses of Oxytocin

Oxytocin is widely used by dairy cattle and milch buffalo owners under the false impression that it improves the milk yield. Introduced earlier to ease milking in hard milkers, this drug became popular among milkmen on account of its low cost and easy availability in the market. To curb its misuse, this drug was lately included among Schedule-H drugs, but the quacks have come with other ways and means to defy such legislative curbs. Now-a-days it is being sold as "Goli number ten"along far and wide of the country. The misuse of Oxytocin in cattle and buffalo is much rampant in India and Pakistan. As per a survey conducted in Uttar Pradesh, Haryana and Delhi, Parashar (1997) concluded that 82% cattle breeders were using Oxytocin injections for milking their cows. The misuse of this drug in Pakistan has been reported by Mustafa *et al.* (2008) and Ahmad *et al.* (2000).

Many questions are currently being asked regarding such unwarranted use of Oxytocin in farm animals. Does the use of Oxytocin really increase the

milk yield in the recipient animals? Does the excessive use of this drug cause any hazardous effects in the animals? Are there any public health concerns while consuming milk from such animals? Mustafa *et al*. (2008) conducted a field study on the effects of Oxytocin on the productive and reproductive performance of buffalo and cattle, and concluded that Oxytocin injection in animals showed decrease in milk yield, decrease in milk fat percentage and also such animals suffered from mastitis during the period. Shaw (1942) while studying the effect of Oxytocin on milk and milk fat secretion concluded that, the injection of Oxytocin at regular milking intervals did not affect the normal milk or fat secretion, but milking at two hour intervals with the aid of Oxytocin decreased milk fat secretion. However, conflicting observations have been recorded by Linda *et al*. (1993), in which they reported that Oxytocin before and after milking significantly increased milk yield by 3%, without affecting general milk composition. Such findings were also supported by Bansode *et al.* (1996). Natzke and Schultz (1996) found that injection of Oxytocin in cows prior to milking caused a significant ($P < 0.01$) reduction in fat and protein percentage of milk and also a reduction in the leukocyte count of milk obtained during post-treatment period. They further reported that milk production and chloride percent significantly ($P < 0.01$) increased. The observations of increased chloride percentage (Natzke and Schultz, 1996) augments the observations of Mustafa *et al*. (2008) that indiscriminate use of Oxytocin increases the incidence of mastitis in animals. Bencini *et al*. (1992), observed that in Merino ewes, all Oxytocin treatments significantly increased the amount of milk extracted ($P < 0.01$), but did not affect fat content of the milk.

In cycling cows and buffalos, the regular use of Oxytocin causes lysis of corpus luteum before time, due to release of PGF2α in response to Oxytocin (Rigby et al. 2001; DeLille *et al*. 1998). This induces premature ovulation and this immature ovum is not capable of fertilization, resulting into infertility. The continuous use of Oxytocin in milking animals causes repeated and continuous contractions of uterine muscles and thus the fertilized ovum does not get implanted (Ahmad *et al*. 2000). Overstimulation of uterine glands due to Oxytocin leads to glandular degeneration and as such no uterine milk is available to the developing embryo during pre-implantation phase, resulting in early embryonic death (Ahmad *et al.* 2000). Donaldson (1969) recorded that excessive use of Oxytocin produced epithelial cysts in the fimbria of the infundibulum, the ampulla of the oviduct and the mucosa of the endometrium of the uterus. He also observed that there was mild cystic endometrial hyperplasia of the uterus, and occasional cyst formation in the rete-ovarii. The epoophoron was dilated and distinct in many

ovaries. Large luteinized follicles, apparently cystic, were also seen when such animals were slaughtered. Mustafa *et al*. (2008) recorded that frequent use of Oxytocin resulted in various reproductive disorders in both cattle and buffalo, including follicular ovarian cysts (18.33%), luteal cysts (28.33%), retention of placenta (11.66%), repeated estrus (25%) in buffalo and follicular cysts (26.66%), luteal cysts (23.33%), retention of placenta (8.33%), repeated estrus (23.33%), respectively in case of cattle. Similar findings were also reported by McDonald (1989), Dominguez *et al*. (1993), Hassan (1993) and Qureshi (1998). They further observed that consumption of milk obtained by frequent Oxytocin injection by calves resulted in delayed puberty, low conception rates, increased incidence of abortion, difficult birth and dead fetuses. Such observations were also confirmed by Siddiqui and Saeed (2000).Donaldson *et al.* (1965) observed that daily injections of Oxytocin during first third of estrous cycle shortened the bovine cycle from about 22 days to 8-12 days. Effects of Oxytocin on bovine estrous cycle were also recorded by Armstrong and Hansel (1959). Guzman *et al.* (1991) observed that excessive use of Oxytocin during labor produces and increases the vaginal and cervical tears, and also high rate of fetal complications including respiratory distress and jaundice. These results were significant at $P < 0.05$.

There has been much debate on the harmful effects of milk obtained after Oxytocin injection. Breast cancer, stunted growth, hair loss and carcinogenic effects are often feared to be associated with such milk. However, Ijaz and Aleem (2006) believe that the reports on the harmful effects of milk produced by Oxytocin treated dairy cattle are misleading. Whether secreted endogenously in response to natural stimuli or administered exogenously, Oxytocin produces the desired effects within minutes and gets metabolized rapidly, leading to inactive products. Till date, there is not a single report which demonstrates the presence of this hormone in the milk (Ahmad *et al.* 2000). Those who imagine that it may escape the action of degrading enzymes and seep into milk in traces should also realize that in such a situation, all the breast-fed infants and newly born calves must be constantly exposed to these traces of Oxytocin in mother's milk all the time without facing any health hazards whatsoever. The reason is that if at all ingested orally along with milk, Oxytocin is bound to be digested like other proteins and peptides due to action of gut enzymes and gastric acids and cannot be absorbed from the intestine to reach the blood circulation again in the intact form.

Also there are reports that Oxytocin is being used by vegetable growers to increase their yield, as it is believed that this hormone increases the size of their produce. The use of this hormone in water melon is widely reported.

However, whether consumption of such vegetables and fruits causes any deleterious effects on the consumers remains to be seen. Reports exist of hundreds of girls being kidnapped from across India and later given Oxytocin injections to hasten their puberty and push into prostitution (Bhalla *et al.* 2010). However, authors failed to see any scientific documents regarding such effects of Oxytocin.

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