Low-Salt Meat Products as Health Food

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Abstract

Vegetarian food is recommended for those who have problem of hypertension. However, if meat is consumed then reduction of sodium chloride i.e. low-salt content is suggested in producing processed meat products. In this paper attempts are made to have detailed review on the aspects of physiological role of sodium chloride in processed meats, salt replacers and their effect on the quality of meat products.

Keywords: Low-salt meat products, Health food, Sodium chloride, Salt replacers.


Introduction

Hypertension has become an important health concern because it may increase the incidence of symptoms associated with coronary heart disease and stroke (Jacobson and Liebman, 1981). Excessive intakes of sodium are associated with hypertension. The essential dietary intake of sodium is 200 mg/day, which is equivalent to 0.5 g of sodium chloride (IFT, 1980), and is adequate to maintain physiological balance, whereas the average consumption of sodium chloride daily is 10-12 g per person in USA and much higher in our country. Thus, there is a need to cut down the excessive dietary intake of sodium.

The concern of reducing sodium in the food supply is important to the processed meat industry. Sodium chloride is a principal ingredient in producing processed meats due to its flavour, preservation and protein solubilising properties. Merely reducing the amount of sodium chloride used in a formulation will affect the water holding capacity and emulsifying properties of meat protein (Wierbicki et al., 1957; Hamm, 1960; Schut, 1975). These effects will result in unstable emulsions.

Studies on reduction or replacement of sodium chloride in processed meats suggest that replacement of sodium chloride with other chloride salts may not be totally desirable for flavour and that reducing levels of sodium chloride may affect the shelf-stability of such products (Olson and Terrell, 1981). In addition to these reports, it is common knowledge that reducing sodium chloride level may reduce product yields, an economic consideration.

Attempts have been made to reduce the sodium content of meat products by replacing sodium chloride with other chloride salts like calcium, lithium, magnesium and potassium (Seman et al., 1980; Hand et al., 1982b). They reported that decreasing salt content considerably affect the textural changes, flavour differences, decreased moisture retention (yield), shortened shelf-life (spoilage microorganisms), safety (pathogenic microorganisms) and even product appearance. FSIS (1973) allowed the expanded use of sodium or potassium phosphates (0.5% level) in certain meat products. It offered a solution for reducing sodium contents in processed meats without a loss of product flavour and functionality.

Hence, in this paper attempts are made to have detailed review on the aspects of physiological role of sodium chloride in processed meats, salt replacers and their effect on the quality of meat products. Knowledge regarding above is of immense help to meat researchers, meat products manufacturers, exporters and policy planners for popularizing low-salt meat products as health foods.

Physiological importance of sodium chloride

Sodium chloride, most frequently encountered in the food supply as common table salt, is an essential part of the human diet. As it dissolves in water, it dissociates into two ions - one of sodium
and the other of chloride. In all mammals, including man, the sodium ion is required to maintain the pressure and volume of the blood. It is also essential in controlling the metabolism of carbohydrates and proteins. The chloride ion, too, is essential, and is involved in maintaining the acid-base balance in the blood and in tissue osmolarity. It is necessary for activating certain essential enzymes, and for the formation of hydrochloric acid in the stomach, needed in the digestive process. Thus, both sodium and chloride are normal and necessary constituents of body tissues and fluids, and must be provided in the diet. But excessive intake of sodium beyond a certain limit is harmful as it leads to hypertension, which may lead to heart attack, heart failure and kidney failure.

**Functions of sodium chloride in processed meats**

Sodium chloride is essential in processed meats, such as frankfurters, corned beef, luncheon meats, sausage, ham and bacon. It performs the following functions: (i) solubilizes meat proteins, which assists in binding meat, moisture and fat in the formation of desirable gel texture; (ii) activates proteins to increase hydration and water binding capacity; (iii) increases the viscosity of meat batters, facilitating the incorporation of fat to form stable batters; (iv) increases the pH of meat systems; (v) essential for flavour; (vi) exerts preservative effect due to its ability to lower water activity by drawing water from the tissues; (vii) decreases fluid loss in vacuum packaged product, which has been thermally processed.

**Salt replacers**

Several approaches can be used to investigate the feasibility of reducing the sodium chloride content of processed meat products by reducing NaCl content only, replacing part or all of the NaCl with other chloride salts, replacing part of the NaCl with non-chloride salt compounds or altering processing techniques with any of the above.

Several studies done or reported in the 1980s assessed the quality effects of the substitution for NaCl by other chlorides (Hand et al., 1982a-c; Marsh, 1983; Terrell, 1983; Terrell et al., 1983). It was during that period that NaCl and other chlorides (Ca, K, Li, Mg) were re-evaluated for their influences on flavour, water binding factors and microbial inhibition (Marsden, 1980; Maurer, 1983; Terrell et al., 1983; Smith, 1988). Partial replacement of NaCl with KCl, up to about 50% replacement, was generally successful without the major negative effects of KCl on flavour. Increasing the KCl proportion was accompanied by increased bitterness and off-flavour (Olson and Terrell, 1981; Marsh, 1983). Hand et al. (1982b) and Terrell (1983) found that LiCl replacement of NaCl came closest to producing the same flavour as NaCl with little off taste. LiCl is not approved as a food ingredient and is considered to be toxic, so has not been applied in commercial practice. Thus, 50:50 blends of NaCl and KCl (as 'lite-salt' or 'half-salt') are often sold and used as a salt replacer/substitute in several applications.

Food acids, particularly lactic, acetic or citric acid, enhances or intensifies the saltiness impact of the salt, or contributes to saltiness itself. Sodium and potassium lactate were used with a corresponding reduction in the NaCl level (Anders et al., 1989; Askar et al., 1994). Hofmann and Marggrander (1989) demonstrated that a particular collagen hydrolysate enhanced saltiness in certain products and might have potential for salt reduction. Natura (1993) has developed a non-salt substitute, called eXalt, composed of lysine and succinic acid. This compound has a salty flavour, and also some antimicrobial and antioxidative properties, and may substitute for some of the functions of salt in meat products. Phosphates, gums or starches can be used to maintain the water binding function lost due to salt deletion.

**Effect of salt replacers on the quality of meat products**

**PHYSICO-CHEMICAL QUALITY**

**Effect on pH**

Terrell et al. (1981) reported that NaCl or KCl increased pH of beef clod muscles while MgCl₂ or CaCl₂ had the opposite effect. Hand et al. (1982c) observed that the raw batters of pork/beef formulations made with 100% or 35% MgCl₂ or made with 100% LiCl, had lower pH values than controls or those made with 100% KCl. Effect of CaCl₂ injection on tenderization of spent hen meat was investigated by Mendiratta et al. (1996). They observed that the pH of the CaCl₂ treated meat is lower than the non-treated meat. Similar findings were observed in
spent buffalo meat (Mendiratta et al., 1997). Lactic acid along with CaCl₂ treatment resulted in lowered pH of poultry muscle (Modi et al., 2001; Kanimozhi & Mendiratta, 2002).

**Emulsion stability**

Maurer et al. (1969) and Hudspeth & May (1967) established the importance of salt soluble proteins in emulsification of poultry meat. According to them the mere presence of salt in a protein solution enhanced its emulsifying capacity. Vadehra et al. (1973) studied the effect of various salts on the water holding capacity of poultry meat. They observed that MgCl₂ and LiCl were two of the more advantageous salts, and CaCl₂ had less of a beneficial effect on emulsifying capacity. Influence of divalent cations on poultry meat emulsions and sausages was investigated, and it seemed that emulsifying capacity of a 3% NaCl extract of chicken white muscle was decreased by 10 mM CuCl₂, slightly increased by FeCl₂, and greatly increased by ZnCl₂, whereas calcium and other cation chlorides showed no effect (Whiting and Richards, 1978). Effect of reduction and partial replacement of sodium on bologna characteristics and acceptability was studied by Seman et al. (1980). They found that NaCl-MgCl₂ had significantly (P<0.05) less stable and firm emulsion than NaCl or NaCl-KCl treatments.

**Water holding capacity**

Water holding capacity (WHC) decreased with an increase in the quantity of salt solution added to various broiler parts (Vadehra et al., 1973). NaCl and KCl increased WHC more than MgCl₂ at higher pH, but at lower pH the reverse was true (Hamm, 1960; Berman & Swift, 1961). In mechanically deboned turkey meat, Gillett et al. (1977) and Barbut (1983) reported that increasing concentrations of NaCl or KCl improved emulsifying capacities and WHC. Injection of optimum concentration of CaCl₂ (250 mM for leg cut and 100 mM for breast cut of spent hen meat) caused significant decrease in WHC (Mendiratta et al., 1996). Similar results were obtained by Perez et al. (1998). Whereas, Wierbicki et al. (1957) reported that magnesium and calcium increased the water holding in ground meat. Absorption of chemical solutions [0.15 M CaCl₂, 0.15 M lactic acid and their mixture (1:1)] resulted in an increase in water content and WHC of chicken muscles (Modi et al., 2001). Water binding capacity significantly decreased (P<0.05) when salt contents of sausages were reduced from 1.5 to 1.0% and when these sausages were made with preblends containing 2.0 or 3.0% salt (Puolanne & Terrell, 1983).

**Salt extractable proteins**

Salt is critical for texture in many meat products because it solubilises the structural proteins (Gillett et al., 1977) and permits them to function as binding agents. The chloride ion is believed to be the major contributor to the enhanced binding ability of muscle proteins, while the sodium ion imparts flavour (Whiting and Richards, 1978). It is well established that pre-rigour meat has a higher water holding capacity and its salt soluble proteins are more extractable than meat that has undergone rigour mortis (Bard, 1965). Use of pre-rigour meat in low-salt products may reduce the normal salt requirement (Puolanne & Terrell, 1983).

Pre-blending is a process, which allows more time for salt extraction of meat proteins in the manufacture of meat products. Pre-blending led to an improvement in emulsion stability in 0.5% NaCl sausages (Ching-Cheng et al., 1993) but did not affect the textural properties of low-salt (1.5%) frankfurters (Hand et al., 1987). It appears that pre-blending can enhance the extraction properties when the level of salt is low (less than 1%).

**Cooking yield**

Addition of salt increased cooking yield in poultry loaves as a result of improved water holding capacity (Schnell et al., 1970). The same was observed in restructured pork chops (Huffman et al., 1981).

Leak et al. (1987) found that the final yield decreased in dry cured ham as KCl replacement level increased. On the other hand, Keeton (1984), investigating the same type of products, did not find differences in the final yields when NaCl was partially replaced with different levels of KCl.

No significant difference was noticed in cooking yields of control and CaCl₂ treated spent hen meat (Kanimozhi & Mendiratta, 2002). This finding is in agreement with the reports of Wheeler et al. (1991) and McFarlane & Unruh (1996) for CaCl₂ treatment of beef and pork. But a significant (P<0.05) increase in cooking loss has been reported in CaCl₂ marinated spent hen meat (Mendiratta et al., 1996).
Shear force value

Leg cuts and breast cuts of CaCl$_2$ treated spent hen carcasses showed significant reduction in shear force value (Mendiratta et al, 1996). Eilers et al (1994) observed 35% reduction in shear values when beef muscles were injected with equal volumes of 0.3M CaCl$_2$ and 0.3M lactic acid. Similar results were observed by Kanimozhi & Mendiratta (2002) and Morris et al (1997).

Force needed to shear a 2.54 cm core of flaked and cured pork product increased linearly (P<0.01) to the 1.5% salt level, then increased slightly to 2.25% and more rapidly to 3.0% salt (Neer & Mandigo, 1977).

Free fatty acids

Lipolytic and oxidative changes were studied in two typical meat products from pork loin, dry-cured loin (DCL) and pickle-cured loin (PCL). Muscle lipolytic enzymes were active in both products and were accompanied by a significant increase in FFA from 0.580% (of total lipid) in fresh loin to 5.65% in DCL and 2.95% in PCL. With respect to oxidative changes, the peroxide value decreased in both products, and the thiobarbituric acid (TBA) number only increased in PCL (Hernandez et al, 1999).

In chicken muscles, FFA amount and oxidation level increased simultaneously and both were higher in thigh muscles than in breast muscles suggesting that lipolysis could promote lipid oxidation (Sklan et al, 1983). Contrary to this, Alasnier et al (2000) reported that chicken thigh muscles contained 3 times more FFA's than breast muscles and 2 to 4 times less TBARS.

TBARS value

Low temperature storage of meat products formulated with salt, such as sausage and ham, undergo oxidative rancidity faster during refrigerated storage than meat products without salt. Salt affects the rate of lipid oxidation, causing cured meats, seasoned with salt to acquire a rancid taste in shorter time than the unseasoned product. TBA values increased with increasing salt levels following freezer storage in restructured pork chops (Huffman et al, 1981). When NaCl was reduced from 2.5% to 1.25% or when these levels were replaced with KCl or MgCl$_2$ in refrigerated ground pork, there were no significant differences in TBA values after 5 days of storage (Rhee et al, 1983).

Poultry meat is very sensitive to the development of oxidative rancidity because of its higher content in polyunsaturated fatty acids. Lipolysis is suspected to promote lipid oxidation because free fatty acids are often regarded as more sensitive to oxidation than esterified ones (Labuza et al, 1969; Nawar, 1996) particularly free long chain PUFAs, which arise from phospholipid hydrolysis (Moerck & Ball, 1974). In chicken muscles, FFA amount and oxidation level increased simultaneously and both were higher in thigh muscles than in breast muscles suggesting that lipolysis could promote lipid oxidation (Sklan et al, 1983). The changes in FFA amount and composition and in TBARS were simultaneously determined in chicken breast and thigh muscles during storage of 14 days (Alasnier et al, 2000). Thigh muscles contained 3 times more FFA's than breast muscles and 2-4 times less TBARS suggesting that lipolysis did not favour lipid oxidation.

Proximate composition

Huffman et al (1981) reported that per cent moisture and fat were not influenced by the addition of salt, while per cent ash and protein changed with salt addition. They recommended a salt level between 0.5% and 1.0% for restructured pork chops. Replacement of NaCl with any chloride salt, except CaCl$_2$ significantly decreased moisture loss in raw and cooked samples, whereas monocalcium phosphate increased moisture loss to that of the control (Terrell et al, 1981). Use of 100% KCl in making frankfurters resulted in higher moisture as compared to those made with 100% NaCl (Hand et al, 1982c). Moisture content of cooked spent hen meat reduced significantly by injection of CaCl$_2$ (Mendiratta et al, 1996). Ash content was high in CaCl$_2$ treated muscles (Kanimozhi & Mendiratta, 2002; Nurmahmudi & Sams, 1997). CaCl$_2$ and lactic acid treatment to layer chicken muscle resulted in 2-5% higher moisture as compared to control (Modi et al, 2001; Kanimozhi & Mendiratta, 2002). Gimeno et al (1998) did not find any difference in the moisture content when a mixture of KCl, MgCl$_2$ and CaCl$_2$ was used as a partial replacement of NaCl with an equivalent ionic strength in dry fermented sausages.
SENSORY QUALITY

Flavour

Sodium chloride has a flavour enhancing effect in meat products in addition to its functions in solubilization of meat proteins and inhibition of pathogens. The level of salt required for an acceptable product depends on the saltiness expected in the product. Thus, simply reducing salt levels in order to reduce sodium may adversely affect product flavour.

Low salt frankfurters (0.5%) were rated significantly lower for flavour than control frankfurters (2.3%). Barbut et al. (1988) found that frankfurters made from 20 and 49% reduced salt formulations had less desirable sensory properties. Wheeler et al. (1990) reported that replacing 35% of the NaCl with KCl did not have any detrimental effect on the sensory properties of restructured beef steaks. Semen et al. (1980) found that a 50% reduction in sodium resulted in a bologna product that was as acceptable as the control product, but further reduction to one third of the control level adversely affected the flavour of the product.

Hand et al (1982c) reported that replacing all of the NaCl with either KCl or MgCl₂ produces a strong off-flavour, initially and throughout subsequent storage periods. Use of LiCl (100% or 35%) to replace NaCl does not produce a strong off-flavour in frankfurters. Bologna with 2.25% NaCl had highest sensory ratings, but replacement with KCl at 1.5% level resulted in bitterness, but polish sausage containing 1.25% KCl was rated higher than bologna with same KCl level (Olson & Terrell, 1981). Hand et al (1987) reported that low salt-low fat frankfurters can be manufactured with textural characteristics similar to control ones. Terrell & Olson (1981) concluded that when substitution levels are greater than 50% of NaCl by KCl, bitter or metallic off-flavour become objectionable. Keeton (1984) found that hams with replacement levels of 66.7% and 100% KCl were unacceptable due to extreme bitterness and samples cured with 33.3% KCl were not different from the control except for a slight degree of bitterness. In fermented sausages and dry-cured pork loin, Gou et al. (1996) reported taste defects in products when more than 30% of the NaCl was replaced by KCl or potassium lactate. Gimeno et al (1999) studied the influence of partial replacement of NaCl by a mixture of salts (1% NaCl + 0.55% KCl + 0.74% CaCl₂) with an equivalent ionic strength to that of the control dry fermented sausages. They found that the obtained product was as acceptable as the control by the sensory panel. Mendiratta et al. (1996) reported that CaCl₂ treated spent hen meat showed significant reduction in juiciness, reduced flavour score and no effect on colour.

Texture

Salt is critical for texture in many meat products because it solubilizes the structural proteins (Gillett et al., 1977) and permits them to function as binding agents. Salt addition linearly increased instron slicing strength values and improved flavour, juiciness and textural properties of restructured pork chops. Salt level between 0.5% and 1.0% is recommended (Huffman et al., 1981). Hand et al (1982b) concluded that complete (100%) or partial replacement (50%) of NaCl with KCl produced more off-flavour in cooked slices, but did not affect other properties of hams (juiciness, saltiness, visual cured colour, processing shrinkage, cooked product yields).

Experiments have indicated that CaCl₂ when infused (Koohmaraie et al., 1990), injected (Wheeler et al., 1993; Mendiratta et al., 1995) or marinated (Whipple and Koohmaraie, 1993) enhanced the rate of postmortem tenderization in bovines and ovineres through activation of calpain proteolytic system that hydrolyses the myofibrillar proteins (Koohmaraie, 1992). In addition to it, this process serves at fortification of calcium levels in the meat. Use of CaCl₂ has been approved by FDA as GRAS at maximum level of 3% of a 0.8M solution (FSIS, 1973). Injection of CaCl₂ solution in ovine LD muscle (Whipple et al., 1994) in spent hen muscles (Mendiratta et al., 1996; Woods et al., 1997; Kanimozhi & Mendiratta, 2002) and beef muscles (Wheeler et al., 1992) produced tenderizing effect.

Effect of partial replacement of NaCl with KCl in dry fermented sausages was studied (Ibanez et al., 1997). It was found that the modified product was slightly less hard but had a better salted taste. Dip treatment of layer chicken muscles in CaCl₂ and lactic acid is effective in improving the tenderness quality ( Modi et al., 2001). Hand et al (1982c) reported that MgCl₂ may enhance the firmness of frankfurters. Sensory evaluation of sausages manufactured without NaCl showed them to be significantly more crumbly than those with 1.5% NaCl (Matlock et al., 1984), an effect
that could be attributed to decreased meat binding and decreased water binding capacity in the absence of salt.

Juiciness

CaCl₂ treated spent hen meat showed significant reduction in juiciness (Mendiratta et al, 1996). Mendiratta et al (1995) reported juiciness improved by CaCl₂ treatment in chicken. Juiciness and overall acceptability of CaCl₂ and lactic acid treated muscles did not differ significantly from control (Kanimozhi & Mendiratta, 2002). In contrast, a number of authors reported improvement in palatability by CaCl₂ treatment in beef and buffalo (Miller et al, 1995; Mendiratta et al, 1997; Perez et al, 1998).

MICROBIOLOGICAL QUALITY

According to Sofos (1986), NaCl is inhibitory against many spoilage and pathogenic microbes in meat because of its ability to reduce water activity.

The use of salt controls the microbiological profile of meat, and a decrease of salt will, in general, decrease the shelf-life. Kraft (1983) concluded that, in general, a 25% reduction of salt did not adversely alter the shelf-life or microbial characteristics of the products evaluated. Effects of different levels of NaCl, KCl and MgCl₂ on microbial growth in ground pork were reported by Terrell et al (1983). Micrococcus, Moraxella or Lactobacillus species served as inocula. The above workers suggest that there may be a real danger of increasing rates of product spoilage when NaCl is lowered or when NaCl is replaced with either KCl or MgCl₂. Terrell et al (1982) reported that replacement of NaCl (2.5%) with an equivalent ionic strength of KCl was more effective for destroying *Trichinella spiralis* larvae in linked pork sausage than was an equivalent amount of MgCl₂ or CaCl₂. In addition, MgCl₂ or CaCl₂ significantly decreased total aerobic plate counts compared to NaCl or KCl. Wheeler et al (1993) reported higher microbial counts in CaCl₂ injected beef samples. Similar type of findings were reported by Whipple & Koohmaraie (1993) and Mendiratta et al. (1996). Seperich & Ashoor (1983) reported no effect on microbial growth in bologna product in which NaCl is replaced with CaCl₂. Very little effect of CaCl₂ is found on microbial qualities of muscle foods (Wheeler et al, 1993; Eilers et al, 1994 and Mendiratta et al, 1997). However, significant reduction in microbial count is observed in CaCl₂ and lactic acid treated muscles (Kanimozhi & Mendiratta, 2002) where they act synergistically. Champagne et al (1993) observed that substitution with KCl did not severely alter the acidification of fermented sausages. Gimeno et al (1998) found that Micrococcaceae showed significantly lower counts when NaCl was replaced by a mixture of MgCl₂, CaCl₂ and KCl in dry fermented sausages.

No differences were detected in the hygienic quality in dry fermented sausages treated with partial replacement of NaCl with KCl (3% NaCl by 1.5% NaCl + 1% KCl), inspite of the higher water activity observed in the treated products (Ibanez et al, 1997).

References


8. Champagne, CP, Fontaine, J, Dussault, F and Delaquis, PJ, Effect of partial replacement of NaCl by KCl on the fermentative activity of mixed


17. Hand, IW, Terrell, RN and Smith, GC, Effects of complete or partial replacement of sodium chloride on processing and sensory properties of hams, J Food Sci, 1982b, 47, 1776.


29. Kooohmaraei, M, The role of Ca2+ dependent proteases (Calpains) in postmortem proteolysis and meat tenderness, Biochimie, 1992, 74, 239-249.


33. Leak, FW, Kemp, JD, Fox, JD and Langloid, BE, Effects of boning time, mechanical tenderization and partial replacement of sodium chloride on the quality and microflora of boneless dry-cured ham, J Food Sci, 1987, 52, 263-266.


46. Moerck, KE and Ball, HR, Lipid autoxidation in mechanically deboned chicken meat, J Food Sci, 1974, 39, 876-879.


55. Rhee, KS, Terrell, RN, Quintanilla, M and Vanderzant, C, Effect of addition of chloride salts on rancidity of ground pork inoculated with


65. Terrell, RN, Childers, AB, Kayfus, TJ, Ming, CG, Smith, GC, Kotula, AW and Johnson, HK, Effects of chloride salts and nitrite on survival of Trichina larvae and other properties of pork sausages, *J Food Protect*, 1982, 45, 281.


75. Wierbicki, E, Cahill, VR and Deatherage, FE, Effects of added sodium chloride, potassium chloride, calcium chloride, magnesium chloride and citric acid on meat shrinkage at 70°C and of added sodium chloride on drip losses after freezing and thawing, *Food Technol*, 1957, 11, 74.

Herbal treatment of bovine dermatophilosis

In tropical and subtropical countries enzootic bacterial skin disease called dermatophilosis in cattle is commonly found. Some times it is so acute that it may lead to death of the animal, and cause economic losses to farmers. Ali-Emmanuel M and others in Republic of Benin prepared and studied the therapeutic effect of a herbal ointment using extracts of medicinal plants. In the preparation of this ointment ethanolic extracts of leaves of *Cassia alata* Linn. syn. *Senna alata* (Linn.) Roxb., *Lantana camara* Linn. and *Mitracarpus scaber* Zucc. were used and applied topically on chronic crusty or acute lesions of dermatophilosis. The ointment induced healing of the disease in the infected animals treated without recurrence. This is opposed to what is observed by using oxytetracycline, terramycin long-acting (TLA), or procaine-penicillin, antibiotics commonly used parenterally for the treatment of dermatophilosis which could not prevent the recurrence of the disease.

These ointments, when applied once a day for 8–15 days, provoked the falling off of the crusts after 3–4 days of treatment. Hair grows on the treated areas, which heal without scarring, within 3–4 weeks after the end of the treatment. The healed animals became free of dermatophilosis without recurrence for more than 3 years and were in good health. Furthermore, these ointments are cheaper, easier to produce and give better results than antibiotics used parenterally, but further experiments have to be performed on a larger scale to capture the full range of severity of the disease and analyse possible resistance to that treatment [Ali-Emmanuel et al, *J Ethnopharmacol*, 2003, 86(2-3), 167-171].

Kakla — A potential weed for animal feed

The scarcity of feed and fodder resources led the scientists of Central Agricultural University, Imphal to study the proximate principle and amino acid composition of *Kakla, Monochoria vaginalis* Presl found as an aquatic weed in marshy and water logged areas in Manipur state. The amino acid assay showed that about 32 per cent of total nitrogen in the weed was of non-protein nitrogen origin hence this can be better assimilated by rumen microbes as a source of nitrogen. The study inferred that *Kakla* weed could be included up to 25 per cent with out any harmful effect in ruminant feed (Singh et al, *Indian Vet Med J*, 2003, 27, 340).