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Physiological Effects of Dietary Complex Carbohydrates and its Metabolites Role in Certain Diseases

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Abstract: Carbohydrate is one of the basic and an important food nutrient consumed worldwide. Like-wise Pakistani foods contain more carbohydrates than any other food nutrient consumed. Sometimes, Pakistani foods are devoid of protein and may contain only carbohydrates and fats as the major nutrients of the diet e.g. eating chapati (wheat bread) with potato curry. Certain non-communicable diseases can be avoided with adoption of proper healthier food habits and eating foods according to the needs of the body. These diseases are obesity, coronary heart disease, colonic cancer and gastrointestinal disorders (diverticular disease, constipation, hiatal hernia and hemorrhoids). Therefore complex carbohydrate should be an important constituent of our daily meal and it can be adopted for the management of certain diseases provided that it is used in proper amounts. Consumption of certain complex carbohydrates is associated with lower body weight, reduced blood cholesterol, reduced blood glucose and an increased crypt cell proliferation. Therefore, it is necessary and utmost important to know the various types of carbohydrates to enable us to decide to include carbohydrates in our daily food according to our health requirements. Not necessarily all the community need to know but at least those who are associated with nutrition and health management must know the beneficial as well as the harmful effects of carbohydrates.

Key Words: Complex carbohydrates, fibres, digestion, absorption, metabolites short chain fatty acids, diseases

Introduction

What are the complex carbohydrates ?: Complex carbohydrates refers to large molecular forms of carbohydrates (resistant starch and dietary fibres); are types of carbohydrates, which are not digested in the upper gastrointestinal tract and are fermented, in the large bowel by the action of various bacteria. The fermentation products are mainly short chain fatty acids (SCFAs) or volatile fatty acids (VFAs), methane (CH_4), hydrogen (H_2) and carbon dioxide (CO_2). The SCFAs produced from the fermentation are absorbed at site of production and transported to the liver via entero-hepatic circulation. The SCFAs play an important nutritional role that is discussed in the proceeding sections.

History and Definition of Complex Carbohydrates: In 1923 Kellogg and others stimulated the study of dietary fibre in the U.S.A. (Kellogg, 1923); however the term "unavailable carbohydrate" was used long before (McCance and Lawrence, 1929). The unavailable carbohydrate was later called "dietary fibre " (Hipsley, 1953) which was defined as "that portion of plant food resistant to hydrolysis by the alimentary enzymes of man" (Trowell, 1976). Kritchevsky (1988) defined as dietary fibres "plant material that resists digestion by human alimentary enzymes". It includes many different substances; with the exception of lignin, all are carbohydrate in nature. Chemically fibre was defined as "non starch polysaccharides (NSP)" (Cummings, 1981). The NSP include cellulose and non-cellulosic polysaccharides (NCP) (Kay, 1982). The latter includes pectin and hemicelloses (structural polysaccharides); fructans, glucofructans, mannans and galactomannan (storage polysaccharides); gums and mucilages (isolated polysaccharides) containing a mixture of pentoses, hexoses and uranic acids (Kay, 1982) Apart from these lignin, protein, cuticular lipids and inorganic constituents, such as silica, magnesium, calcium and potassium are associated with the plant cell wall polysaccharides (Cummings, 1981). There is substantial evidence that some starch resists digestion in the upper gastrointestinal tract (GIT) and can act as a potential source of substrate for fermentation in the large bowel (Cummings and Englyst, 1987). This starch is known as resistant starch (RS) (Cummings and Englyst, 1987) and has been recently redefined as " the sum of starch and products of starch degradation not absorbed in the small intestine of healthy individuals". Due to various chemical substances which could contribute to dietary fibre early definitions were inappropriate and the British Nutrition Foundation's Task Force introduced a new term "Complex carbohydrates" which includes both NSP and starches (British Nutrition Foundation's Task Force, 1990). In the UK, the term dietary fibre has been replaced in nutrition labeling by nonstarch polysaccharides (British Nutrition Foundation's Task Force, 1990 and Prosky, 2000).

Types of Complex Carbohydrates: Generally, complex carbohydrates are grouped into two major types; I) soluble complex carbohydrates and ii) insoluble complex carbohydrates. The soluble complex carbohydrates are soluble in water, viscous in nature and nearly hundred percent fermentable in large bowel whereas the insoluble complex carbohydrates are insoluble in water, non-viscous in nature and slowly fermentable in large bowel (Roberfroid, 1993). When these complex carbohydrates are eaten as a part of meal or fed to the experimental subjects behave differently and exhibit different physiological effects. For example, soluble complex carbohydrates may be helpful in the management of diabetes mellitus whereas the insoluble complex carbohydrates may be helpful in the management of constipation, diverticulitis, haemorrhoids and large bowel cancer (Gumaa *et al*., 2001; Muir *et al*., 1993). The classification based on it chemical nature is given in Table 1.

Complex Carbohydrates and Certain Diseases: Several diseases have very close link with complex carbohydrates. These diseases are cardiovascular diseases, ulcer, dental caries, constipation, appendicitis, obesity, varicose vein, colorectal cancer and diabetes mellitus. To understand the link between these diseases and complex carbohydrates it would be essential to know the process of digestion of the complex carbohydrates and their end products of digestion and metabolism.

Digestion of Complex Carbohydrates: Most starch is digested in the small intestine with glucose as the absorbed product but some

Table 1: Major types of non-starch polysaccharides (NSP)

Primary Source	Major Group	Components Present	Summary of structures	Distribution in Foods
Structural Materials of Plant Cell Wall	Cellulose	-	Long-Chain β-Glucans	-
	Non-Cellulosic Polysaccharides	Pectic Substances	Galacturonans	Mainly in Fruits and
			Aarabinoglactans	Vegetables
		Hemicellulose	Arabinoxylan	
			Glucuron- Arabinoxylan	Cereals
-			Glucuron-xylan	Fruits and Vegetables
			Xylo-glactans	
			β-Glucans	Cereals
Non-Structural Polysaccharides	Gums Mucilages		Wide Range of Hetro-Polysaccharides	Seed and Fruits

British Nutrition Task Force, (1990)

Table 2: The principle substrates thought to be available for fermentation for large intestinal bacteria in a person consuming Western diets (Cummings and Macfarlane, 1991)

Substrate	Amount (g/d)
Non-starch polysaccharides	8-18
Resistant starch	8-40
Oligosaccharides	2-8
Unabsorbed sugars	2-10
Dietary protein	3-9
Pancreatic enzymes and other gut secretions	4-6
Mucus	2-3
Sloughed epithelial cells	Unknown

starch escapes digestion in the small intestine. All NSP escapes small intestine digestion because there is no mammalian enzyme capable of hydrolysing plant cell wall polysaccharides. Dietary NSP are not digested in the upper GIT but are extensively fermented by the bacteria to produce short chain fatty acids (SCFA) as major end products and some other metabolites. Acetate, propionate and butyrate are produced in the approximate molar ratio of 60: 25: 15 (Cummings and Englyst, 1987), but this can vary depending upon the nature of the carbohydrate being fermented (Weaver *et al.*, 1992).

Fermentation of Complex Carbohydrates: In the digestive tract of monogastric animals including man, micro-organisms ferment a wide range of endogenous and exogenous substrate (Table 2) to produce SCFA, methane, carbon dioxide and hydrogen in a manner similar to rumen fermentation (Cummings and Englyst, 1987). Fermentation of food is achieved by the concerted action of bacteria through anaerobic breakdown. Polymeric substrates are hydrolysed to their monomeric units, glucose, galactose, xylose, arabinose and uranic acids and then fermented via glycolysis to pyruvate and eventually to SCFA (mainly acetate, propionate and butyrate) together with some gases (Smith and Bryant, 1979; Wolin and Miller, 1983).

In rats, the molar ratio of the three major SCFA (acetate, propionate and butyrate) is greatly influenced by the diet. Key and Mathers (1993) observed a strong linear relationship between the amount of substrate (whole meal bread) supplied and the molar proportion of butyrate. Feeding purified NSP and RS (Tulung *et al.*, 1987; Walter *et al.*, 1988) or diets rich in NSP readily change the SCFA pattern in rats (Cheng *et al.*, 1987; Mathers, 1990; Goodlad and Mathers, 1990). Apart from the substrate, alteration in the bacterial population (Goodlad and Mathers, 1990), pH (Finlayson, 1986), bacterial growth rate (Silley and Armstrong, 1984) and caecal transit time (TT) (Mathers and Dawson, 1991) may affect the molar proportion of the SCFA. Changes in the pattern of branched chain SCFA are usually the net balance between production of these SCFA and their use for bacterial protein synthesis (Rasmussen *et al.*, 1988).

Absorption of Metabolites of Complex Carbohydrates: Short chain fatty acids are absorbed in the monogastric animals including man via passive diffusion in a manner similar to that observed for rumen epithelium (Levrat *et al.*, 1991; Fleming *et al.*, 1991). Alternatively, it has been proposed that SCFA may be absorbed via anionic exchange (Ruppin *et al.*, 1980; Argenzio and Southworth, 1977). Short chain fatty acids could be absorbed as un-dissociated acids (non-ionic diffusion), or sodium or potassium salts of short chain fatty acids (ionic diffusion) (Fleming *et al.*, 1991, Ruppin *et al.*, 1980; Argenzio and Southworth, 1977). The absorption has been shown to be accompanied by luminal increase in HCO_3^{-1} and decrease in CO_2, and by increased absorption of sodium, potassium and water. SCFA are most effectively transported at pHs lower than 7.0 and it has been proposed that in the human large intestine 60 % of SCFA are absorbed in the un-dissociated acid form (Ruppin *et al.*, 1980).

Energy contribution of SCFA in different species: Table 3 summarises estimates obtained in various species for the contribution of SCFA to the energy requirement of the whole body but this has been shown to vary with the type and amount of dietary intake. For example Ruppin *et al.* (1980) calculated that SCFA could supply 22 % of the energy requirements in human subjects whilst other estimates (Cummings, 1981; Grossklaus, 1983; McNeil, 1984) are much lower at 2-7 % based on 20 g of fibre fermentation daily.

Metabolism of SCFA: The SCFA are directly absorbed at the site of production and may be metabolised either locally in the gut, by the liver or by peripheral tissues. The SCFA absorbed may then be used for maintenance, growth and lipogenesis. The enzymatic activation of SCFA by formation of their respective acyl-CoA eg. acetyl-CoA, propionyl-CoA and butyryl-CoA are important factors regulating the rate of uptake of SCFA by different tissue (Bergman, 1990). Rat colonocytes have been shown to possess a butyryl-CoA synthetase which is more active than the acetyl-CoA and propionyl-CoA synthetases (Roediger, 1982). Most of the butyrate is usually oxidised to CO_2 and ketone bodies in pig (Imotso and Namiokka, 1978), rabbits, (Marty and Verny,1984), rats (Roediger, 1982) and humans (Roediger, 1982) by the colonic mucosa during its transportation to the bloodstream. Some of the propionate is also metabolised by the gut. The remaining butyrate, propionate and acetate are transported to the liver via

Table 3: Estimates of contribution of SCFA produced in different sections of the digestive tract of various species to energy requirements of the whole body

Species	Organ	% of Energy requirements	Reference
Rat	Caecum	5	Yang *et al*. (1970).
Human	Large intestine	6-10	McNeil (1984).
Pig	Large intestine	11	Imotso and Namiokka (1978) and Kim *et al*. (1978).
Pig	Total hind gut	25	Rerat *et al*. (1987).
Rabbit	Caecum	12	Marty and Verny (1984).
Rabbit	Total hind gut	30	Marty and Verny (1984) and Parker (1976).
Pony	Caecum	30	Glinsky *et al*. (1976).

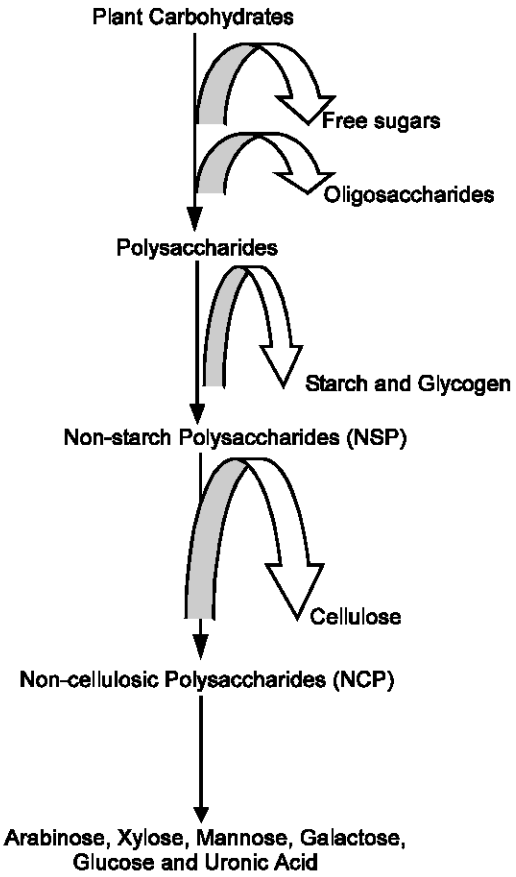

Fig. 1: Separation of plants carbohydrates

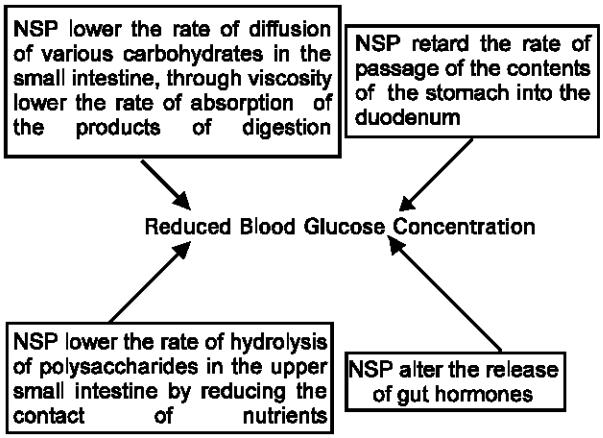

Fig. 2: Mechanism of action of NSP on blood cholesterol

the portal vein (Bergman, 1990). The liver removes propionate and butyrate very efficiently and the uptake is close to 100 % whereas acetate uptake is generally limited in the liver. Goodlad and Mathers, (1990) observed very low concentrations of propionate and butyrate in peripheral blood and it has been observed that acetate comprises 90-98 % of the SCFA present in both arterial and peripheral blood (Bergman, 1990).

Metabolism of acetate: In ruminants only a small proportion of the absorbed acetate is utilized by the liver and acetyl-CoA synthetase activity is low in ruminant liver (Bergman, 1990). The acetate metabolism of monogastric animals varies from species to species. For example, lipogenesis occurs in humans and birds mainly in the liver whereas in ruminants and pigs lipogenesis occurs in adipose tissues (Bauman and Davis, 1975; Leaft, 1983; Pearce, 1977). In rodents, lipogenesis occurs in both tissues. These differences in lipogenesis seem related to metabolism of acetate since acetyl-CoA can be easily incorporated into lipogenesis. In some studies it has been shown that hepatic acetate uptake is directly proportional to the concentration of acetate in the portal vein (Buckley and Williamson, 1977; Remesy *et al*., 1980). In ruminants, acetate carbon is incorporated into fatty acids by both adipose tissue and the mammary gland more rapidly than is glucose carbon (Ballard *et al*., 1969; Ballmain *et al*., 1954; Vernon, 1981) whereas in rats glucose is the preferred substrate (Ballmain *et al*., 1954). Acetate can be a significant source of fuel for skeletal muscles (Snoswell *et al*., 1982). However, the quantitative importance and the metabolic fate of acetate in the simple stomach species such as humans and rats are not well understood.

Metabolism of propionate: Propionate is partially metabolised by the gut epithelium and liver takes up most of the remainder. Propionate is the only SCFA that can be a major source of glucose; acetate, butyrate and longer chain SCFA with an even number of carbon atoms cannot contribute to net synthesis of glucose. This is because these SCFA are converted to acetyl-CoA only and the acetyl-CoA enters the tricarboxylic acid (TCA) cycle. When acetyl-CoA enters the cycle two carbon atoms are lost as CO_2 and there is no net gain of oxaloacetate and, therefore, no net glucose synthesis is possible (Weinman *et al*., 1957). The propionyl-CoA synthetase activity has been reported to be greater than acetyl-CoA synthetase activity (Ash and Baird, 1973 and Demigne *et al*., 1986) as a result of which most of the absorbed propionate is removed by the liver (Goodlad and Mathers, 1990; 1991). Once propionate is absorbed, it can be used for gluconeogenesis or for energy production via the TCA cycle. In

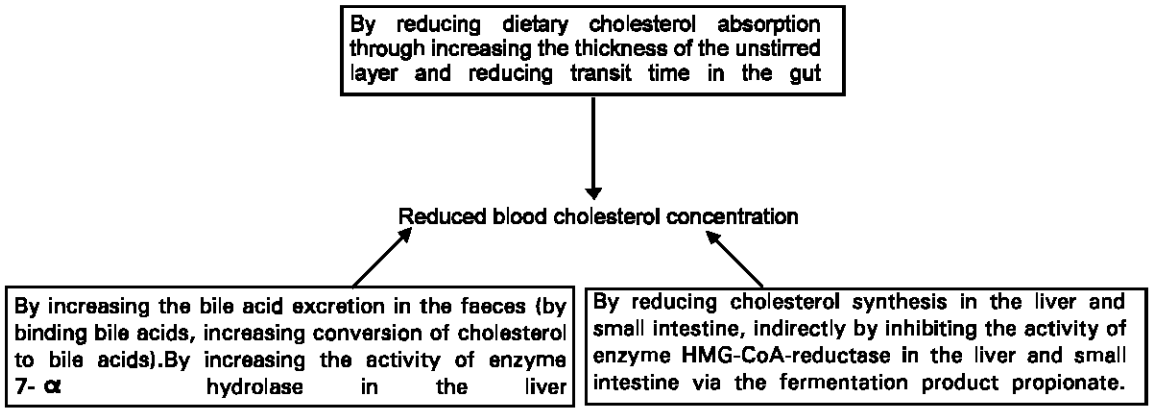

Fig. 3: Mechanism of action of NSP blood cholesterol

ruminants propionyl-CoA carboxylase activity has been shown to decrease during starvation; feeding feed rich in grain increases its activity and the amount of propionate absorbed (Baird and Young, 1975). Biotin and vitamin B_{12} have been shown to be essential for the metabolism of propionate (Elliot, 1980). However, the net contribution of propionate to glucose production in simple-stomached animals is still not clear.

Metabolism of butyrate: Butyrate is metabolised by rumen and gut epithelium and by liver. Large amounts of butyrate are taken up by the gut epithelial tissue and by the liver. It has been suggested that only trace amounts can enter the post-hepatic bloodstream. The metabolic pathways of butyrate in ruminants and non-ruminants seem to be similar. Peripherally butyrate is utilised for the production of energy or used for lipogenesis and is removed for milk fat synthesis (Annison *et al*., 1963; Black *et al*., 1961). Butyrate is readily oxidised by isolated rat hepatocytes (Roediger, 1982) and is an important source of energy for human colonocytes (Roediger, 1980). In liver, butyrate is converted to butyryl-CoA by an enzyme butyryl-CoA synthetase (Ash and Baird, 1973; Dougherty, 1984). Then it is rapidly converted to acetyl-CoA, longer chain fatty acids or to ketone bodies (Bergman and Kon, 1964; Katz and Bergman, 1969).

Effect of Complex Carbohydrates on Glucose Metabolism: The consumption of certain soluble NSP such as pectin and guar gum has been shown to lower postprandial blood glucose and insulin responses (Jenkins *et al*., 1978) whereas the consumption of insoluble NSP such as wheat bran or cellulose are ineffective (Jenkins *et al*., 1978). The mechanisms it involves are not established but proposed mechanisms of action of dietary NSP on blood glucose concentration are described in Fig. 2. Early studies using soluble viscous sources of NSP such as guar gum demonstrated that they could impair the glucose absorption (Jenkins *et al*., 1977; Jenkins, 1983). In comparative studies it has been shown that the most viscous NSP seem to be the most effective; for example bran has little effect while guar gum produces the largest response (Edwards *et al*., 1987; Jenkins *et al*., 1978). The increased viscosity is probably involved in the reduced convective currents induced by the smooth muscle contractions (Blackburn *et al*., 1984). Probably this action reduces the degree of mixing and thereby preventing the access of the nutrients in the luminal bulk phase to the absorptive epithelium. The rate of absorption is decreased and more food travels down the gut (Jenkins, 1983). It has been proposed that intestinal absorption of nutrients (final digestion products of SI) depends on the thickness of the unstirred layer (unstirred diffusion barrier) overlaying the absorptive surface of the SI. Viscous soluble NSP have been shown to reduce the interaction between the nutrients and enzymes and the rate of absorption (Flourie *et al*., 1984; Low, 1988). Guar gum has been reported to increase the viscosity of the gut contents (Johnson, 1990) and alter the mucosal enzymes activities (Elsenhans *et al*., 1981). Mathers (1992) reported that guar gum feeding to rats had no effect on the maltase activity but sucrase activity was reduced in the proximal SI and the activity was increased in the distal ileum. The suggested mechanisms are presented in the Fig. 2.

Effect of Complex Carbohydrates on blood cholesterol: Feeding some NSP reduces blood cholesterol concentration in humans as well as in experimental animals (Gumaa *et al*., 2001; Anderson *et al*., 1991; Nishina *et al*., 1991; Aro *et al*., 1984; McIvor *et al*., 1986). Dietary NSP has been suggested as a natural and useful hypocholesterolaemic agent (Jenkins *et al*., 1980). The effect on blood cholesterol depends on the type and quantity of dietary NSP eaten (Hundemer *et al*., 1991; Leadbetter *et al*., 1991; Lopez-Guisa *et al*., 1988; Shinnick *et al*., 1990; Hollenbeck *et al*., 1986; Kestin *et al*., 1990; Albrink *et al*., 1979). The dietary NSP and some dietary fats can alter the hepatic LDL receptor activity (Norum, 1992; Topping *et al*., 1990). The reduced blood cholesterol concentration usually involves a reduction in the low-density lipoprotein (LDL) cholesterol fractions whereas high-density lipoprotein (HDL) cholesterol is increased (Nishina *et al*., 1991). This may be of particular importance in the light of the present evidence that the occurrence of CVD is strongly related to decreased HDL cholesterol concentration (Drexel *et al*., 1992; Assmann and Schulte, 1992) and increased LDL cholesterol concentrations (Grundy, 1990). Work with experimental animals including rat, rabbit, chicken and swine have indicated that the supplementation of atherogenic diets with soluble NSP sources retards the progression of atherosclerosis whereas insoluble NSP do not have this effect (Kritchevsky, 1982; Kritchevsky, 1990). However, the exact mechanism of action is not clear and is open for further research.

Proposed mechanisms of actions of Complex Carbohydrates: The proposed mechanisms by which dietary NSP reduce blood cholesterol concentration include physical effects for example increased digest viscosity, enhanced bile acid excretion and altered digestion and absorption of lipids (Topping, 1991) as indicated in the Fig. 3.

Reduced cholesterol synthesis: One of the leading hypotheses has been the inhibition of cholesterol synthesis in hepatocytes via the fermentation products SCFA (especially propionate) Illman *et al*., 1988. Thacker *et al*. (1981) and Thacker and Bowland (1981); Boila *et al*., (1981) reported that feeding 5 % propionic acid in the diet lowers blood cholesterol concentration in pig. It has also been reported that the addition of propionic acid at concentration of 15 and 30 mM to bovine liver homogenate inhibited HMG-CoA reductase activity (Bush and Milligan, 1971). These concentrations of propionate are very much higher than those found *in vivo* so the practical significance of these observations must be in question. With isolated rat hepatocytes propionic acid inhibits cholesterol and fatty acid synthesis using ^{14}C-acetate, $^{3}H_2O$ and ^{14}C-mevalonate as tracer (Ide *et al*., 1978). However, in human subjects, it has been shown that feeding sodium propionate at the rate of 7.5 g/d in a capsule form did not lower the serum total cholesterol but increased HDL cholesterol concentration (Venter *et al*., 1990).

Complex Carbohydrates enhance faecal bile acids excretion: The cholesterol lowering effect of dietary NSP could be predominantly because of the interruption of the bile acid circulation (enterohepatic cycle). Studies with dietary guar gum in rats have been shown that the activity of the enzyme 7∝-hydrolase (EC 1.14.13.17) which is the rate limiting step in the conversion of cholesterol to bile acids in the liver is increased and at the same time there is increased faecal bile acid excretion (Ide *et al*., 1990). It has been observed that other dietary NSP increase the 7 á-hydrolase activity in the liver of rats and decrease the bile acid pool (Ide *et al*., 1990; Marcus and Heaton, 1986; Arjmandi *et al*., 1992; Turley *et al*., 1991). In hyperlipidaemic subjects 40-50 g of pectin /d reduced blood cholesterol concentration; this decrease was associated with the increase cholesterol elimination of bile acids in the stool which is then balanced by enhanced cholesterol synthesis (Arjmandi *et al*., 1992; Ebihara and Schneeman, 1989; Story, 1985). In this respect, soluble NSP act in similar way to the bile acid sequestrant such as cholestyramin but this effect is associated with the type of NSP fed to the experimental subjects (Turner *et al*., 1990). Similar effects have been observed *in vitro* with different dietary NSP sources on bile acids (Story and Kritchevsky, 1976).

Viscosity and transit time: The ingestion of soluble NSP increases the viscosity of the contents of the stomach and small intestine and therefore might interfere with digestion and absorption of lipids (Topping *et al*., 1988 and Blackburn and Johonson. 1981) in similar way to that described earlier.

Effect of NSP on Crypt Cell Proliferation (CCP): There is substantial evidence in the literature that soluble NSP sources increase epithelial cell proliferation in the gut (Pell *et al*., 1992; Lupton *et al*., 1988) but the mechanism for this effect is not established. There seems to be many different mechanisms involved simultaneously in increasing the intestinal CCP, such as the increased delivery of organic matter (OM) to the large bowel (Mathers *et al*., 1993). The increased supply of OM to the large bowel stimulates bacterial fermentation resulting in increased SCFA production and a more acidic pH. Increased concentration of SCFA and reduced pH may be responsible for the elevated CCP (Lupton and Kurtz, 1993). Sakata (1987) reported that CCP was stimulated in the caecum and colon by butyrate injection into the caecum. Goodlad *et al*., (1989) reported that dietary NSP sources increase the CCP in the small intestine and colon in conventional rats whereas CCP was not affected in germ-free animals and concluded that it is the fermentation product which increase the cell proliferation. Another, mechanism by which the soluble NSP may influence intestinal cell growth is through the binding of luminal inorganic ions (James, 1980), such as calcium, which is considered to be important in the control of cell proliferation (Durham and Walton, 1982). Soluble NSP bind bile acids which have been shown to damage the mucosal cell surface causing higher rates of cell sloughing and resulting in compensatory stimulation of cell synthesis (Jacobs and Lupton, 1984). It has been shown that hormones play an important role in the regulation of epithelial cell proliferation and soluble NSP affect gut hormones such as entero-glucagon and gastrin (Pell *et al*., 1992; Winsette *et al*., 1986).

Conclusions: Consumption of certain complex carbohydrates is associated with lower body weight, reduced blood cholesterol, reduced blood glucose and an increased crypt cell proliferation. A possible mechanism of action is related to viscosity and gel forming abilities.

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Study on Pork Characteristics of Chinese Wuzhishan Mini-Pig

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Abstract: This research was conducted to evaluate the meat traits of Wuzhishan mini-pigs (WZSP). Young Xiang-pigs (XPs) and adult Beijing Black-pigs (BPs) were used as the control group of young and adult WZSPs respectively. Studies included evaluation of carcass properties, meat sensory character, edible quality and processing performance. The studies show the WZSP is of thin skin, low back-fat, high lean percentage and meat productivity. The results of meat quality analysis indicate the WZSP pork is of fresh meat color, good elasticity, less marbling, rich amino acid especially pre-flavor amino acid and low intra-muscular fat. Meanwhile, WZSP pork presents benign processing performance of low loose water percentage, low drip loss, and eminent bounding water capability.

Key Words: Wuzhishan mini-pig (WZSP), carcass property, sensory characteristics, edible quality, processing performance

Introduction

Wuzhishan mini-pig (WZSP) is a special pig in China. The WZSP initially lived in isolated tropical areas in Hainan Province, an island in southern China and was inbred for a long time. In the 1980s Chinese scientists investigated animal species around the country and found that the WZSP was on the edge of extinction. Therefore, it was designated as one of the preserved species owning to its rareness in the world in 1985. The experts in the Institute of Animal Science of CAAS (Chinese Academy of Agriculture Science) brought the last three pigs (two sires and one sow) to Beijing and began breeding them there. Since then, the study on WZSP has been an important national project. Through more than a decade of efforts, much progress has been made. For example, the inbreeding of WZSP has reached fifteen generations and the inbreeding coefficient is more than 0.956.

The process of species preservation is implemented in the steps of investigation, evaluation, protection and usage. Investigation and evaluation are the precondition of usage. Usage is the assurance of protection. The usage of WZSP meat in food processing industry and customer consuming requires mass breeding and feeding. That is the best preservation of WZSP.

Now the ninth generation of WZSP has been born and the total number of pigs has reached more than 200. The most exciting thing is that the feeding of WZSP on a large scale is possible due to modern artificial insemination and advanced feeding techniques. Pork quality is very important not only to consumers but also to food industry. This makes the study of meat traits necessary. Under this background, studies on carcass properties and meat traits of WZSP were done which included meat sensory character, edible quality, and processing performance. In the experiments, three young Xing-pigs (Xps) were used as the control group for young WZSPs because of their likeness in bodily form and rear. Three Beijing Black-pigs (BPs), the most common meat pig, were also used as the control group for adult WZSPs.

Pork is an important nutrition resource in human's daily life. Therefore it is significant not only for customers but also for food industry to evaluate pork traits. The research will be helpful to further meat development and utilization of the WZSP.

Materials and Methods

Animals: Six WZSPs were obtained from a research breeding farm of the Institute of Animal Science under Chinese Academy of Agriculture Science. Three of the pigs were two months and the others were six months. Three BPs of six months were also obtained from the farm. Three XPs were provided by Tai Ping High Tech Agriculture Company (Huhehaote, P. R. China), these were young of two months.

Before being slaughtered the pigs were transported from the research station to the abattoir and left in the lariage for approximately 2 hours. The animals were stunned with CO_2 and exsanguinated. Thereafter the carcasses were submitted to standard slaughter procedures and cut according to the routines described by Yuming and Ming (1994).

Carcass property analysis: Carcass property analysis was performed according to Regulation for Performance Testing Techniques of Lean-type Breeding Pigs in China Standard (National Standard Bureau of People Republic of China, 1999). The attributes of the analysis includes dressing percentage, thickness of back fat and skin, ham proportion, eye muscle area, percentage of lean meat, back fat, skin and bone, and meat productivity. After slaughtered, the head, ears, and feet of pig are cut off, then split it into two half and weigh it. The proportion of the weight of carcass to total gross weight is the rate of slaughter. Measure the thickness of back fat and skin between the sixth and seventh rib with vernier caliper. The proportion of the weight of ham vertically chopped off between the last two lumbers to the weight of carcass is the percent of ham and lip. Cutting off form the joint of lumber and thoracic vertebra, picturing with transparent paper of sulphuric acid then according to the formula: height to width to 0.7, the eye area is counted. The proportion of the weight of thin meat to the total weight of thin meat plus fat and bone is the rate of thin carcass meat. According to the rate of thin carcass meat, thickness of back fat and the content of intra-muscular fat, meat productivity evaluation can be taken.

Sensory analysis: The sensory characteristics of pork mainly include meat color, meat marbling and meat elasticity. Meat color and meat marbling were determined as described by Runsheng (1987). If the score is 1, the meat color and marbling were the worst while 5 is the best. Samples for meat color measurement were taken from Longissimus dorsi muscle between lumbars. Samples for marbling determination were taken from Longissimus dorsi muscle between the last two ribs. Meat elasticity was classified to three levels, good, normal and poor, according to the reflection of hand pressing.

Edible quality analysis: In edible quality analysis, the contents of moisture, ash, crude protein and intra-muscular lipid were determined as described in Food Analysis (Wuxi Light Industry College, 1990). To better investigate the nutrition of WSZP pork, the compositions of meat amino acids and fatty acids were also analyzed. All samples for edible qualities were taken from the Longissimus dorsi muscle between 4th and 7th lumbars and stored in refrigerator at -18 °C until analysis.

Amino acid analysis: Samples for amino acids analysis were grounded by a meat chopper and dried in an oven. The 50 mg of dry ground pork was hydrolyzed for 24 hours with 20 ml 6.0 N hydrochloric acid at room temperature. Supernatant liquid was filtered by 0.45μm filter paper and diluted to 100 ml by distilled water. Amino acid profile was analyzed by an automatic amino acid analyzer (Shimadzu 835-50 type, Japan), equipped with a flame ionization detector (FID). The amount and concentration of liquid hydrolysis for analysis were 50 microlitres and 3 nmol respectively. Separation was carried out on a chromatogram column (2.6 mm×150 mm) with 53 °C and 80-90 kilograms per square centimeter pressure. The type of ion exchanging column was 2619#. The total analysis recycling time was 70 min. The buffer exchanging was divided into five steps at a flow rate of 0.225 ml min^{-1}. The pressures of ninhydrin and nitrogen gas were 15-35 kilograms and 0.28 kilograms per square centimeter respectively. The flow rate of ninhydrin was 0.3 ml min^{-1}. Individual amino acid peaks were identified by comparing their retention times with the standards. Results are expressed as percentage of amino acids.

Fatty acid analysis: Total intra-muscular lipids were extracted and quantified according to the standard method (National Standard Bureau, 1999). The pre-treatment of samples for fatty acid composition analysis needs three steps: extraction, saponification and methoxy-esterify.

Extraction of lipid: After adding 10ml of tri-chloromethane/methanol (2:1) solution to 2g minced meat, the mixture was homogenized for 10 minutes. Then the supernatant liquid was filtered with a 0.45μm filter paper. The 2 ml-distilled water was added to the filtrate and mixed. The resulting mixture was placed for 30 minutes without shaking. In order to get pure lipid, 1ml of liquid from the under layer was taken into a cuvette and the appropriate nitrogen gas was poured into it.

Lipid saponification: To prepare for lipid saponification, 5ml 0.5N NaOH/formaldehyde was added to the lipid and the mixture was heated to reflux for 5 minutes.

Fatty acid trans-esterification: Fatty acid methyl esters (FAMEs) were prepared by acidic-trans-esterification in presence of BF_3 /formaldehyde solution.

Before further analysis, 3 ml n-hexane was added into the FAMEs and the reflexing was carried out for 1 minute. After adding suitable saturated NaCl solution, the mixture stood still for ten minutes. 1 ml liquid from the upper-layer was taken to a tube by a transfer pipette. Thereafter, the suitable anhydrous sodium sulfate was put into the tube to dehydrate the FAMEs.

The dehydrated FAMEs were analyzed by gas chromatography using a Shimadzu GZ-9A gas chromatography (Shimadzu, Japan) equipped with a flame ionization detector (FID). Separation was carried out on a Silar7CP chromatogram column (3.1mm×3mm) at 205 °C. Injector and detector temperatures were 230 °C. Carrier gas was nitrogen at a flow rate of 1.8 ml/min. Individual FAME peaks were identified by comparing their retention times with standards. Results can be expressed as percentage of selected fatty acids.

Process performance analysis: Performing analysis was carried out using the method of Measurement of Pork Quality (Runsheng, 1987).

Determination of pH_1 was carried within 45 minutes after slaughter on the third rib muscle and determination for ultimate pH (pH_u) was performed on muscle stored for 24 hours at 1-5 °C. Dipping the electrode of pH determination instrument (pHS-25 type, Shang Hai) directly into the measuring portion, the presented digit was pH value.

Sample for measurement of water holding capacity was taken from the Longissimus dorsi muscle between the 1st and 2nd lumbars. It was made to slides of 1.0 cm thickness and 5.0 cm^2, then was put between two piece of gauzes with eighteen layers of filters padded up and down. A piece of hard plastic backing was put outside the filters. After a press of uniform velocity to 35 kg and maintaining for 5 min, the sample was weighted immediately. The calculate format was as following:

$$\text{Water holding capacity \%} = (W_1-W_2) / W_1$$

where W_1 is the weight of meat sample before pressed, and W is the weight of pressed meat sample.

Samples for drip loss determination were taken from the third lumbar. It was cut transversely from the longest muscle of back into slides with 2 cm thickness, then repaired to cube of 5 cm to 3 cm to 2 cm and weighed (W_1). Hook the end of sample with wires and let muscle fiber vertically, then put it into food plastic pack and let sample keep off the wall of pack, tie the pack and put it in icebox under 4 °C for 72 hours, then weigh it at 24, 48 and 72 hours respectively (W_2). The equation for calculating percent drip loss is as follows:

$$\text{Drip loss \%} = (W_1-W_2) /W_1 *100\%$$

where W_1 is the weight of meat sample before hooking, and W_2 is the weight of meat sample after hooking.

Sample for cooked meat percentage was taken from the middle of largest waist muscle. After wipe off the attaching fat and film, the sample was put into boiler and heated with water to boiling for half an hour. The meat was hooked for 15 min in cool place and weighed. The equation for calculating percent cooked meat is as follows:

$$\text{cooked meat percentage} = (W_1-W_2) /W_1 *100\ \%$$

where W_1 is the weight of sample before being boiled, and W_2 is the weight of boiled sample.

Statistical analysis: Data were analyzed using the marked test as described in Probability and Application of Statistics (Zhou, 1988). The difference of twin data sets can be calculated based on the formula of $d_i=x_i-y_i$ (suppose that they all come from a normal distribution sample population N (μ, d)), and the expectation and variance of the samples (d_1, d_{-2}.d_n) are represented as d and s^2 respectively. Then T test is performed. The significance level is 0.05. If the t value is within the range of rejection threshold, then the twin data sets are significantly different and otherwise are not.

Results and Discussion

Carcass property : According to the data shown in Table 1, the dressing percentage of WZSP was significantly lower ($P<0.05$) than that of the control group. Because dressing percentage is closely related to weight (Yuming and Ming,1994) and the slaughter weight of WZSP was the lightest, the conclusion of low dressing percentage of WZSP could not be reached.

Ham percentage is increasing according to monthly age growing (Yuming and Ming, 1994). Compared to the same age pigs of

Table 1: Results of carcass properties (Average n=3)

Variation	Young WZSP	Adult WZSP	Young XP	Adult BP
Slaughter weight (kg)	10.40±0.40	46.00±1.90	5.60±0.20	90.00±1.90
Dressing percentage %	56.00±1.17	67.27±1.67	69.60±0.70	70.31±1.53
Skin thickness (cm)	0.17±0.01	0.28±0.01	0.21±0.01	0.38±0.03
Back fat thickness (cm)	0.28±0.01	0.92±0.03	1.56±0.07	2.04±0.03
Ham percentage %	21.43±0.35	27.71±0.21	26.31±0.05	32.00±0.47
Eye muscle area (cm2)	9.56±0.17	34.28±0.27	6.36±0.16	28.20±1.27
Lean meat percentage		62.16±1.14		58.82±1.44

Table 2: Results of sensory character (n=3)

Variation	Young WZSP	Adult WZSP	Young XP	Adult BP
Meat color				
fresh meat	2.60±0.12	2.86±0.14	3.27±0.13	2.92±0.11
cool meat	2.74±1.21	2.95±1.27	3.30±1.24	2.96±1.19
Elasticity				
fresh meat	better	better	good	common
cool meat	better	better	good	common
Marbling				
cool meat	2.10±0.09	2.46±0.12	3.50±0.10	3.33±0.14

other kinds, the ham of WZSP was less plump. Its percentage was significantly lower ($P<0.05$), 21.34% of young WZSPs and 27.71% of adults, compared with 26.31 and 32.00% respectively of the control group.

Generally, thickness of skin, back fat and area of eye muscle increase with the growth of animal weight (Yuming and Ming, 1994). Young WZSPs were heavier than young XP, but their thickness of skin and back fat were thinner than those of XP and the differences were obvious ($P<0.05$). The larger the eye muscle area is, the higher the lean meat percentage. The average weight of adult WZSPs (46 kg) was much lower than that of adult Bps (90 kg). However, the average eye muscle area (34.28 cm^2) was greatly higher than that of BP (28.20 cm^2), which displayed thick back muscle characteristic of WZSP. The eye muscle area of young pigs can not be determined because of their small size.

The lean meat percentage of adult WZSP (62.16%) was notably higher than that of the control group (58.82%) ($P<0.05$) and higher than that of the standard lean meat type pig (60%). In the meantime, according to the standard assessment of pork productivity of lean meat type pigs, the WZSP received very high score (124), much more than 90 (the basic score of the first class of lean meat pig). Therefore it can be concluded that the WZSP is an excellent lean meat type pig.

Sensory analysis : Meat sensory attributes are key factors affecting consumption, especially fresh raw pork. The attributes mainly include meat color, meat marbling and meat elasticity. The values of the meat sensory attributes were obtained as shown in Table 2.

Table 2 showed that the score of meat color of WZSP was between 2.60 to 2.95. It was lower than that of the control group (3.27-3.30 for XP, 2.92-2.96 for BP), as well as the average score of China local pigs (3.22), but slightly higher than or almost the same as that of some world famous kinds of pig, such as the average 2.25 for Changbai pig, 2.63 for Landerisi pig. Therefore the meat color is normal.

The score of meat marbling of WZSP (2.46) was obviously different ($P<0.05$) from that of the control group in the experiment, 2.10 and 2.46 for young and adult WZSP respectively, while 3.50 and 3.33 for young XP and adult BP respectively. The results displayed that the WZSP meat deposits less intra-muscular fat.

All samples were cut from healthy bodies, therefore they did well in elasticity, especially the meat of WZSP. Although the WZSP was bred in Beijing, far from its homeland. It was fed by up-to-date methods. The meat still looked better. This could be related to its small body and special pork traits originated in long term free range rearing.

Edible quality analysis:

Routine components analysis: Results in Table 3 showed that there was little difference between pigs in the control group and the WZSP of the same age in terms of water, ash and crude protein contents, but the intra-muscular fat of WSZP was extremely low.

It was found that the intra-muscular fat content of WZSP was almost the lowest among Chinese local pigs, except Zhejiang Zhongbai pig (Table 4, Guanghong, 1999).

Fat is an important caloric source. For the same amount of meat, the caloric provided by meat from WZSP was lower than that from XP and BP by 82.5 and 32.5% respectively. Therefore the pork from WZSP is one of the best sources of low-caloric meat.

Amino acid analysis: Meat is the most important source of protein for humans. The nutrition value of protein is determined by the composition and content of its amino acid, especially the composition and content of the essential amino acid.

As far as the same age pigs were concerned, the total amount of amino acid in 100 mg dry meat from WZSP was obviously higher than that from the control pigs, 76.79 and 72.352% for young WZSP and XP respectively, 78.521 and 67.093% for adult WZSP and BP respectively. It was shown that there was rich amino acid in WZSP meat (Table 5).

From the data in Table 5, two conclusions were drawn. Firstly, to young pigs, the contents of Methionine, Isoleucine, Lysine and Threonine in WZSP meat were significantly higher, the content of Valine showed no obvious difference, but the content of Phenylalanine and Leucine in the meat of WZSP were lower. According to the recommendation for the ideal mode of the essential amino acid by World Health Organization, the nutrition values of amino acid in two meats were of no obvious difference. Secondly, compared to BP, the essential amino acid contents of WZSP meat were higher except Met.. This indicated that WZSP pork had better nutrition value than that of BP.

Fatty acid analysis: Results obtained from fatty acid

Table 3: Results of routine nutrition components determination(n=3)

Variation	Water %	Ash%	Crude protein%	Crude muscle fat%
Young WZSP	78.87±0.71	1.04±0.06	19.85±0.09	0.24±0.04
Adult WZSP	75.40±0.86	1.26±0.05	20.70±0.50	2.26±0.03
Young XP	77.41±0.95	1.05±0.02	19.87±0.77	1.37±0.05
Adult BP	73.73±1.44	1.00±0.04	20.21±0.25	3.35±0.17

Table 4: Intra-muscular fat percentage of some local pigs in China

Variation	Jinhua Pig	Wujin Pig	Ming Pig	Liangguang Xiaohua Pig	Zhejiang Zhongbai Pig	BP	WZSP
Intra-muscular fat %	3.70	3.08	5.22	8.27	1.95	5.45	2.26

Table 5: Results of amino acid determination (mg/100mg dry meat)

Variation	Young WZSP	Adult WZSP	Young XP	Adult BP
Aspartic acid	7.301	7.588	6.712	6.491
Threonine	3.227	3.413	2.929	2.878
Serine *	2.541	2.681	2.112	2.331
Glutamic acid *	12.834	13.242	11.056	11.099
Glycine *	3.375	3.585	3.311	3.124
Alanine *	4.501	4.678	4.338	3.953
Cystine	0.993	0.855	1.717	0.818
Valine	4.299	4.525	4.123	3.791
Methionine	1.560	0.742	1.348	1.163
Isoleucine *	3.700	3.837	3.335	3.163
Leucine *	6.000	6.215	6.873	5.276
Tyrosine	3.251	3.025	2.888	2.620
Phenylalanine	2.833	2.856	3.055	2.435
Lysine	6.662	7.037	5.808	5.934
NH_3	1.823	2.113	1.576	1.640
Histidine	3.667	3.381	2.706	2.977
Arginine	5.963	6.191	5.682	5.262
Tryptophan				
Proline *	2.267	2.557	2.783	2.138
Total AA	76.797	78.521	72.352	67.093
Total pre-AA*	35.218	36.795	33.808	31.084

*: pre-flavor amino acid, Total pre-AA *: Total important pre-flavor amino acid

determination were listed in Table 6. Compared to the control groups, we found that the content of polyunsaturated fatty acids and total unsaturated fatty acids in WZSP meat was lower, while the content of the saturated fatty acids was higher. Compared to XP, the content of 18:2 was significantly lower and the content of 18:1 was considerably higher, but there was no obvious difference in total unsaturated fatty acids. The content of 18:0 was higher while there was no large difference between the content of 16:0 and 14:0, but the total saturated fatty acids were higher. Compared to BP, the content of 18:2, 18:1 and total unsaturated fatty acids were all lower and the content of 18:0, 16:0, 14:0 and total saturated fatty acids were higher. Therefore, we came to the conclusion that the fatty acids composition in WZSP meat was not as expected.

With the rise of living standards, the occurrence of modern culture diseases is increasing. When people eat meat or meat related food products, they are afraid of ingesting the inner high calories and cholesterol. As mentioned before, the meat of WZSP was low in intra-muscular fat. After calculating the quantity of total intra-muscular fat in every 100 g pork, it was found that the quantity from young WZSP meat was much lower than that of the control group, and there was no significant difference between quantity of meat from adult WZSP and BP. Thereby it could be concluded that the WZSP meat was low in cholesterol and calories.

Table 6: Results of fatty acid determination(n=3)

Fatty acid	Young WZSP	Adult WZSP	Young XP	Adult BP
18:3 (n-3)			1.29	2.11
18:2 (n-6)	13.75	13.79	18.33	25.61
18:1 (n-9)	39.00	40.39	36.60	42.34
18:0	10.64	13.91	11.93	9.16
16:0	26.31	24.75	24.68	15.82
14:0	1.93	1.46	1.36	0.79
12:0	0.08	0.07	0.07	0.04
Total SFA	38.96	40.19	38.04	25.81
Total MUFA	39.00	40.39	36.60	42.34
Total PUFA	13.75	13.79	19.62	27.72

SFA: saturated fatty acid MNFA: mono-unsaturated fatty acid PUFA: poly-unsaturated fatty acid

Analysis of flavor related factors: Some amino acids, including Ser., Glu., Gly., Ile., Leu., Phe. and Pro. are the necessary pre-flavor amino acid of meat smell (especially Glu). They are directly associated with the flavor of meat (Guobing, 1994).

Compared to XP (Table 7), the contents of Leu. and Pro. in WZSP meats were lower, the contents of Gly. and Ala. were almost the same, and the contents of Ser., Ile. and Glu. were higher. On the whole, the total amount of important pre-flavor amino acids in WZSP pork was higher than that in XP. Compared to BP, the amounts of all pre-flavor amino acids were higher. These components contributed much to the unique meat flavor of WZSP pork which led to the prediction of dense taste and smell after proper processing.

Fat oxidation is the main way to produce flavors. Different derivations of fat oxidation result in different flavors. According to related research, 90% of aroma substance is from lipid reaction, especially when considering that saturated fatty acids are highly correlated to unique flavor. The higher the content of polyunsaturated fatty acids is, the lower the assessment values of tenderness, juiciness, aroma and acceptable extent are. Otherwise, the higher the contents of saturated and mono-unsaturated fatty acids are, the higher the above assessment value is.

The content of 18:2 in meat from WZSP was significantly lower, while the contents of 18:1 and saturated fatty acids were notably higher compared to that from the same age XP. The amounts of 18:2, 18:1 and total unsaturated fatty acid were considerably lower and total saturated fatty acid content was noticeably higher compared to that from BP in the same age. In addition, the mini-type body of WZSP has short muscle fibers which makes meat tender. This resulted in the special flavor and highly acceptable sensory characteristics after the meat was cooked.

Process performance analysis: Process performances mean that whether the meat can be further processed. These properties

Table 7: Comparison between important pre-flavor amino- acids (n=3)

Variation	Ser	Giu	Gly	Ileu	Leu	Ala	Pro	Total
Higher than	26.94	19.7	8.28	19.3	-9.57	7.84	-8.12	4.17
young XP%		7		1				
Higher than	15.02	19.3	14.7	21.3	17.8	18.3	19.6	18.37
BP%		1	6	1	0	4	0	

Table 8: Results of process performance determination

Items	pH_1	PH_u	loose water%		cooked meat%		drip loss %		
			4h	24h	braise	cook	24h	48h	72h
Adult WZSP	6.70	5.76	2.37	14.50	55.40	54.06	1.15	1.57	2.06

include water-holding capacity, emulsification, ability of producing gelatin, cooking loss, cooking color etc (Ruitong, 2000). Among these properties pH value, water-holding capacity, cooked meat percentage, and drip-loss are important, especially to meat juiciness and the loss during cold-storage, transportation, thawing and cutting. Usually, cooked-meat percentage is used to measure cooking-loss.

Data in Table 8 show the following:

First, the change of pH value in the meat from WZSP had no remarkable difference from that of BP, which showed the similar biochemistry-physiology procedure especially the accumulation of lactic-acid in the postmortem.

Second, the drip-loss level of the meat from WZSP was significantly lower than that from BP, while the loose-water had no obvious difference. This indicated that the WZSP meat has better water-hold capacity , which would have significant economic benefit especially in the circulation of raw meat.

In the end, though the meat of WZSP had relatively better water-holding capacity, the cooked-meat percentage of WZSP was lower than that of BP and other local kinds of pig, its lower intra-muscular fat content might be the main factor.

Conclusions: Although the dressing percentage of WZSP was somewhat lower and the ham was less full, the thin skin, thin back-fat, thick back-muscle and high meat productivity of WZSP showed the excellent characteristics of lean meat type of pig. Pork of healthy WZSP was of perfect meat color, meat elasticity and less marbling. Moreover, the pork had high edible qualities, such as rich in both amino acid content and composition, and low in intra-muscular fat, which was also expected. Although its fatty acid profile was not satisfying, there was less fat and calorie compared with the same amount of other types of pork. Because of the composition of amino acids and fatty acids as well as short meat fibers, the cooked meat tasted and smelled very good. In addition, the pork still had good process performance.

It is suggested that the further study on WZSP meat flavor should be carried on and the breeding of WZSP should be rapidly developed in the future.

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Energy and Nutrients Intakes of Male and Female University Students

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Abstract: Male and female students residing in the on campus hostels were explained the aim and importance of this study. Among the students registered were 30 male and 30 female who volunteered to participate in this study. The age range of the registered students was 22 – 26 years. On the day of the registration the age, height and weight were recorded and at the same time, they were given food frequency questionnaires (FFQs). They were asked to record alternately for three days whatever they ate during the prescribed week. Out of sixty students 51 (22 male and 29 female) returned the FFQs and the rest were excluded from the study. From the anthropometry, the weight and height for the given ages were compared with the international standards. From the FFQs the energy and nutrients intake was calculated using the food composition table for all students and compared with the recommended nutrients intakes (RNIs) reported by the FAO/WHO for the same age, height and weight. The total energy consumption was more in the female students than in the male students. Eighty two percent of the male and 21% of the female students had lower energy intake than their RNIs for energy. Eighty two percent of the male students had lower relative energy from protein and 91% had lower energy from carbohydrate intake than their respective RNIs. Similarly, in 48% of the female students had lower relative energy from protein and 76% had lower energy from carbohydrate intake than their respective RNIs. The relative contribution of energy from fat was higher in 95 % of the male and 97 % of the female students than their RNIs. The mean mineral intake was lower both for male and female students with the exception that the intake of P was more than the RNIs by 18.4 and 11.5 % for the male and female students respectively. The mean Fe intake was more than the RNIs by 37.3% in male students. Similarly, the vitamins intake was lower as well, both in male and female students with exception that they were having higher intake for vitamin A and C. Apart from these nutrients, all the students surveyed had lower dietary intake of fibre and cholesterol. This study indicates that the students are at the risk of specific nutrient deficiencies and the energy requirement is mainly met through dietary fat intake instead of carbohydrate.

Key Words: Energy, nutrients, intakes, anthropometry, nutritional status

Introduction

Proper nutrition is important in improving the community health in general and of the risk groups in particular. Balance nutrition can protect against many diseases/disorders resulting from nutrient deficiencies or excess. Under nutrition in terms of protein and energy results in poor growth, poor resistant to bacterial or viral infection and to the very known disorders of kwashiorkor and marasmus (WHO, 1979). The consumption of more sugar and fat (particularly saturated fat) is associated with the development of diabetes (Jenkins *et al*., 1978) and heart diseases respectively (Gurr, 1984; David, 1994). The minerals and vitamins deficiencies result in many biochemical and physiological defects. It is just possible that minerals and vitamins may have role in the utilization of the major nutrients (protein, carbohydrates and fats). Faulty nutrition aggravates a wide spectrum of disease condition, diminishing the quality of life, personal productivity and longevity as well. The knowledge of the nutritional status of a community is important for proper planning in the health sector. The nutritional status of a community indicates that whether or not the intakes of the macro and micronutrient are adequate, deficient or in excess. Nutritional status of an individual's is determined by anthropometric measurements, comparison of nutrient intakes with reference values or by biochemical investigations of nutrients related parameters. The anthropometric measurements and comparison of nutrient intakes with reference values are easy and noninvasive, economical and sufficiently reliable method for the determination of nutritional status (Jelliffe, 1966; McMahahon and Bistrain, 1991). According to some recommendation, the combination of the macro-nutrient should be in such a way that protein, carbohydrate and fat provide 15, 55 and 30 % energy respectively of the total body required energy (Health and Welfare Canada Nutrition Recommendation, 1990). The present study was designed to assess the nutritional status of the students by anthropometric measurements and by comparing the energy and nutrient intake with the standard reference values of energy and individual nutrient of the university students.

Materials and Methods

Location and Sample Size of the Study: The study was conducted in the campus of the NWFP, Agricultural University, Peshawar, Pakistan. The importance of the study was explained to the students of the university. Sixty (30 male and 30 female) students volunteered for the study and registered.

Anthropometry and Activity Level of the students: An ordinary measuring tape was used to measure the height whereas weight was determined by common health balance. Their body builds (frame size) was determined by the method of Bray, 1978. From their daily routine, their activity levels were determined (Krause and Mehan, 1984; Williams, 1999). The height, weight, frame sizes and activity levels were noted in the FFQs provided to the students

Collection of Data: The data was collected on FFQs, which contained the information on height, weight, body builds or frame size, activity level and daily food intake for three alternate days of the week. The registered students were asked to record everything they ate in the questionnaire provided to them for the prescribed three days (Monday, Wednesday and Friday). After a week, 22 male and 29 female students returned the FFQs. Out of 60 students eight males and one female student did not return the FFQs and were dropped out from the study.

Compilation of the Data: The observed height and weight of the students were arranged in chronological order according to

Table 1: Mean weight, reference weight and % increase or decrease over reference weight

Height (in)	Nos. of Individuals	Mean Weight (lbs.)	*Reference Weight (lbs.)	% Increase or Decrease Over Reference Weight
Male				
65	3	135 ± 5	133(121-152)	+ 15
66	4	138 ± 11	136(124-156)	+ 15
67	6	141 ± 10	140(128-161)	+ 0.7
68	6	147 ± 9	145(132-166)	+ 1.4
69	3	143 ± 5	149(136-170)	- 4.0
	22			
Female				
59	1	95	104(99-122)	- 8.7
60	2	110 ± 5	107(96-125)	+ 2.8
61	3	106 ± 10	110(99-128)	- 3.6
62	3	106 ± 13	113(102-131)	- 6.2
63	7	122 ± 17	116(105-134)	+ 5.2
64	9	125 ± 7	120(108-138)	+ 4.2
65	1	120	123(111-142)	- 2.4
66	1	130	128(114-146)	+ 1.6
67	2	130	132(118-150)	- 1.5
	29			

*Jelliffe (1966)

Table 2: Relative contribution of macro nutrients to energy intake

Sex	Observed relative energy contribution (%)			[1]Energy Requirements (kcal.)	Energy Intakes (kcal.)	% Increase or Decrease Over Reference Intake
	Protein	CHO	Fat			
Male (N=22)	11.9±1.7	44.2±4.7	44.0±5	2663±419	2605±377	-2.8
Female (N =29)	12.4±1.4	47.5±3.5	40.1±3.4	1753±133	1753±127	0.0
[2]Reference	15	55	30	-	-	-

[1]World Health Organization (1983, and 1985) and [2] Health and Welfare Canada Nutrition Recommendation, 1990.

Jelliffe, 1966. From the three days food intakes data, the average daily food intakes for the students were calculated. The nutrients namely protein, carbohydrates, fats, cholesterol, fibre, minerals (Ca, P, K, Na, Fe) and vitamins (Retinol or A, Thiamin or B_1, Riboflavin or B_2, Niacin or Nicotinic acid and Ascorbic Acid or C) in the average daily eaten food were determined by using the food composition tables (Williams, 1999; Goplan, 1981). The energy content of the daily average eaten food by the students was calculated by multiplying the daily eaten protein, carbohydrate and fats with 4, 4 and 9 respectively (Williams, 1999; Goplan, 1981). The reference intake for the individuals of various heights from the desirable body weights according to the procedure given in American Dietetic Association, 1996a. The data was compared with the available international standards for the evaluation of nutritional status (FAO/WHO, 2000, WHO, 1985, FAO, 1988, Recommended Daily Allowances,1980, McMahan and Bistrain, 1991; Health and Welfare Canada Nutrition Recommendation, 1990; The American Dietetic Association, 1996b).

Statistical Analysis: The mean and standard deviation for the different aforementioned variables were determined by using a statistical package (MINITAB).

Results

The students assessed for the nutritional status both male and female were having body weight for height in the range of reference weight for the observed heights. However, when the mean body weights were compared with the median reference weights, some of the male and female students were having lower body weights (Table 1).

The male students were having inadequate energy intake (lower by 2.18%) whereas the female students exactly met the reference energy intake (Table 2). However, it was reverse when the energy intake was calculated on per kg body weight basis the male students were having adequate energy and female students were having inadequate energy intake (Table 3). The mean dietary intake of protein was adequate in both male and female students on the basis of the WHO recommendation (Table 4) and based on body weight (Table 3) but inadequate on the basis of % contribution to the energy level (Table 2). The intake of dietary cholesterol and fibre was lower both for male and female students (Table 4). The dietary intake for vitamins namely, A, B_1, B_2, niacin and C was adequate for male students whereas it was inadequate for the female students with exception for vitamin C (Table 4). In minerals, the dietary intake for P was adequate both for male and female students. The dietary intake for Ca, K and Na was lower than the recommended RNIs for both sexes. The Fe intake was adequate for the male students and inadequate for the female students (Table 4).

Discussion

The mean energy, protein, carbohydrate, fibre, cholesterol, minerals and vitamins were calculated and compared with the international standards for both male and female students respectively. The adequacy of the nutrients was assessed in different ways. (1) The mean intake was compared with the reference values (WHO, 1985, FAO, 1988, Recommended Daily Allowances, 1980; McMahan and Bistrain, 1991). (2) The energy contribution by the macro-nutrients was calculated and compared accordingly with the recommended dietary intake of 15, 55 and 30 % protein, carbohydrates and fat respectively (Health and Welfare Canada Nutrition Recommendation, 1990). (3) The energy and protein intakes were compared with recommended

Table 3: Comparison of energy and protein requirements based on body weight

Sex	Nos. of Individuals	[1]Mean Weight (lbs.)	Protein Required (g)	Actual Intake (g)	Energy Required (k.cal)	Actual Intake (k.cal)
Male	22	142.1±9.2	51.7	77.6±12.4	2583	2663±377
Female	29	117.8±13.0	42.8	54.5±6.6	2142	1753±127

[1]The mean weight was converted to kg and multiplied by 40 and 0.8 for the required energy and protein respectively (The American Dietetic Association 1996a).

Table 4: Mean (±SD) Energy and Nutrients Intake of the University Students

Name of Nutrient	Actual Intake	Reference Intake	% Increase or Decrease over Reference Intake	Actual Intake	Reference Intake	% Increase or Decrease over Reference Intake
	Male (N = 22)			Female (N = 29)		
[1]Energy (kcal.)	2605±377	2663±419	-2.18	1753±127	1753±133	0.0
[1]Protein(g)	77.6±12.4	53	38.7	51±7	44.5	14.6
Carbohydrate (g)	288± 55	_	_	212±18	_	_
Fat (g)	127± 22	_	_	80± 11	_	_
[2]Cholesterol (mg)	288± 55	300	-40	208± 18	300	-31
[2]Fibre (g)	6.1±2.7	25	-75.6	5.6±1.91	25	-77.6
[3]Vitamin- A (RE)	703 ± 136	600	17	605± 245	500	21.6
[3]Vitamin-B_1 (mg)	0.94±0.5	1.2	21.66	0.83±0.32	1.1	-22.7
[3]Vitamin- B_2 (mg)	1.04 ± 0.37	1.3	20.0	1.0± 0.44	1.1	-9.0
[3]Niacin (mg)	13.24±4.39	16	17.3	10.9± 3.29	14.0	-22.1
[3]Vitamin-C (mg)	66.19± 45.14	45	47.1	67.97± 38.72	45.0	51.0
[3]Calcium (mg)	659±162	1000	-34.1	623± 217	1000	-37.7
[4]Phosphorus (mg)	947±274	800	18.4	892±323	800	11.5
[4]Potassium (mg)	919±282	3750	-75.5	1095± 337	3750	-71
[4]Sodium (mg)	376±192	2200	-82.9	353± 243	2200	-84
[3]Iron (mg)	15.1±5.1	11.0	37.3	13.8±2.8	24	-42.5

[1]World Health Organization (1983 and 1985); [2]American Dietetic Association (1996b); FAO/WHO (2000) and Food and Nutrition Board, National Academy of Sciences-National Research Council RDA (1980)

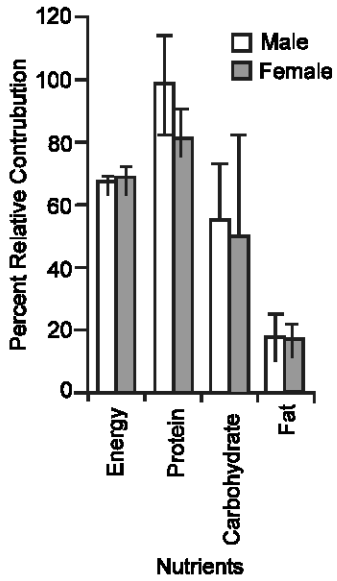

Fig. 1: Mean ± SD percent energy, protein, cholesterol and fiber intake in the diet of the recommended dietary intakes for the university students. The values are the mean ± SD percent intakes of 22 male and 29 female students of the university hostels.

energy and protein intakes/kg body weight of the university students (American Dietetic Association, 1996b). The total energy consumption was more in the female students than in the male students were. Out of 51 students 27 (53%) claim to have had more energy than their RNIs. Among these students 23 (79%) were female and only four male (18%). When the numbers of the male students were expressed in terms of percentages, 13 % had higher energy intake than their RNIs, 5% hardly met their RNIs and 82 % had lower energy intake than their respective RNIs. The percent mean ± SD is shown in the Fig. 1. In the female students 21 % had lower than their respective RNIs 17% met their RNIs whereas 62% had higher intake than their RNIs for energy. However the mean percentage energy intake was higher in the female students when compared with reference energy intake (Fig.1). Apart from this, the intake of the dietary cholesterol and fibre was lower than the recommended level of the RNIs (American Dietetic Association, 1996b).

Based on the WHO/FAO recommendations, both the male and female students consumed highest amount of protein per day when compared with the RDA of the same age and body size, the mean % intake of the RDA for protein was 147 and 103 % for male and female respectively. When the students were individually assessed for the adequacy of protein intake on the basis of RDA for protein per day, only one out of 51 student had lower protein intake in the female students (WHO, 1985; McMahan and Bistrain, 1991). On the other hand when these students were assessed for the adequacy of protein, carbohydrates, fats and energy values in their diets, they were all having inadequate protein according to the recommendation of 15 % protein, 55 % carbohydrates and 30 % fat (Health and Welfare Canada Nutrition Recommendation, 1990). The lower intake on the basis of the relative contribution of macronutrients to the energy among the students, who did not meet the RNIs, was

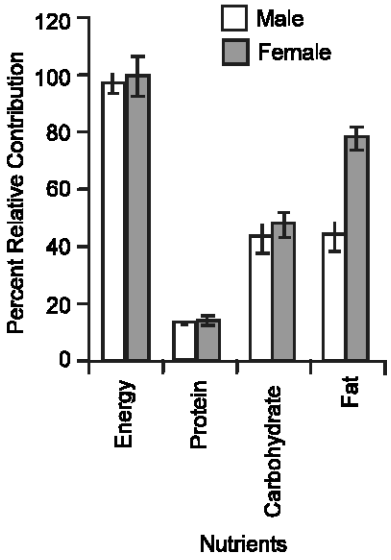

Fig. 2: Relative contribution of protein, carbohydrate and fat of recommended energy intakes of the university students. The values are the mean ± SD of 22 male and 29 female hostel students

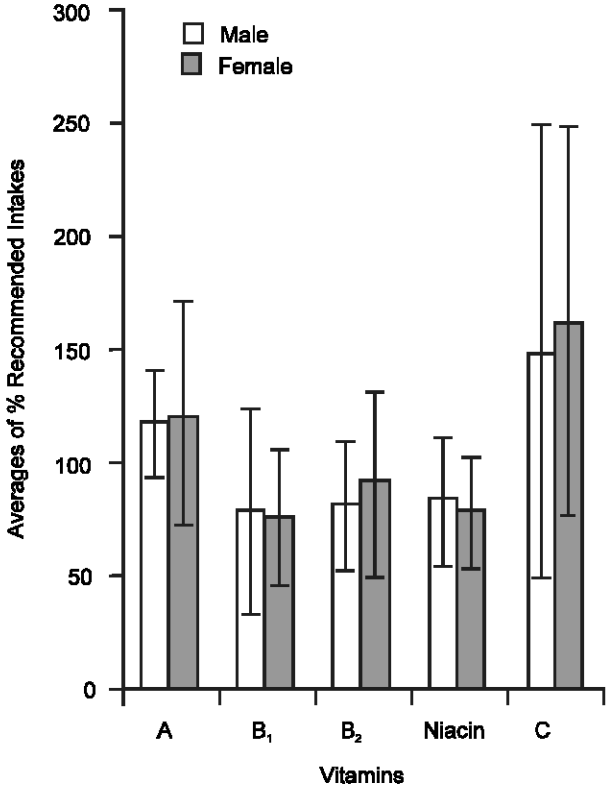

Fig. 3: Mean ± SD vitamins (A, B, phosphorous, potassium, sodium and iron) intake in the diet of the recommended dietary intakes for the university students. The values are the mean ± SD percent intakes of 22 male and 29 female students of the university hostels

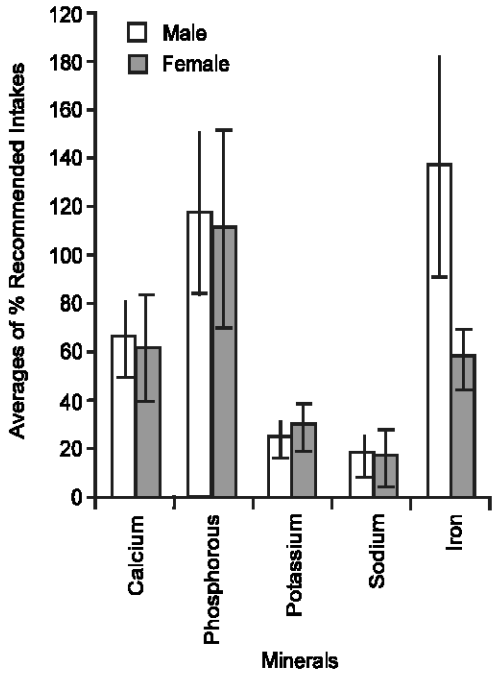

Fig. 4: Mean ± SD minerals (calcium, phosphorous, potassium, sodium and iron) intake in the diet of the recommended dietary intakes for the university students. The values are the mean ± SD percent intakes of 22 male and 29 female students of the university hostels.

reflected either by lower intake of protein or carbohydrates both in male and female students. The intake of fat seems to be adequate among all the students in both sexes. The RNI was not only met by all of the students, infect, it was higher than the recommended RNI for fat. The students having met their RNI for energy consumption were having more fat in their diets instead of protein or carbohydrate. The percentages mean ± SD of the RNIs is indicated in the Fig. 1 and 2 respectively.

Both sexes had adequate intake of vitamin A and C whereas the intake for other vitamins such as B_1, B_2, and niacin was lower than their RNIs. The % means ± SD of the RNIs for vitamins are indicated in the Fig. 3.

In the male students only P and Fe intake was higher than the RNIs whereas the intake for Ca, and Na was lower than their RNIs. The mean % intake of the recommended level for Ca, P, K, Na and Fe was 65.9, 118.3, 24.5, 17.1 and 136.4 % respectively. The percent mean ± SD intake for their RNIs for mineral is shown in Fig. 4. Similarly, the minerals assessed in the females diets, only P appeared to be adequate and the % intake of the RNI was 111.5%. However, the overall intake of the minerals and vitamins was lower in the female students. The consumption for minerals for example Ca, K, Na and Fe was 62.3, 29.2, 16.1, and 57.5 % respectively. The added salt was not considered in the calculation since it was not recorded. Therefore, the intake for salt might be adequate if it would have been recorded. The % means ± SD of the RNIs for minerals are indicated in the Fig. 4. The present study indicates that the students were at the risk of specific nutrients due to faulty intakes.

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Rice Straw Losses and its Impact on Livestock Rearing in Bangladesh

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Abstract: The existing practice of storing rice straw, routes of straw losses and problems related to livestock rearing in rural areas were studied in four selected villages of Mymensingh district of Bangladesh. The base line information on storage system of rice straw and livestock rearing problems were collected through PRA technique using a pre-designed questionnaire. From the survey it was identified that majority of the farmers stored rice straw traditionally making stack on the ground in unroofed condition and that caused considerable damage and losses of straw resulting shortage in the availability of rice straw for animals. Farmers reported that straw is lost in three stages - during harvesting, processing and storage condition. Harvesting loss was accounted for about 8 and 10% for Boro and T. aus straw, respectively. In wet season 25 and 23% of Boro and T. aus straw respectively, was lost during processing. About 18-20% of straw was lost during storage, which was mainly due to earthen evaporated gas, rat, termites, *anjona* (a reptile pest), poultry birds and excessive rainfall. In case of storage of rice straw the single most common solution for many problems as recommended by the farmers was to improve storage system. It may be concluded from the above results that traditional storage method leads to significant loss of rice straw resulting in feed shortage and impaired livestock productivity.

Key Words: Rice straw, routes of straw losses, impact, livestock rearing

Introduction

In Bangladesh ruminant animals are mainly fed on low quality roughage based diets. About 70% of the roughage available is crop residue and rice straw contributes about 87% of the dry roughage available for cattle and buffaloes (Tareque, 1991). Due to inadequate production of green grasses, rice straw has become the major feed resource for livestock production in Bangladesh. In some areas of the country rice straw constituting over 90% of dry matter intake due to lack of alternative feed resources. However, wet weather leads to serious losses in the quantitative and qualitative availability of straw due to heavy rainfall. Post harvest losses of rice straw during wet season due to spoilage is a major contributing factor to the subsequent feed shortage. In Bangladesh it has been estimated that about 7.7 million tons of rice straw dry matter is being rotten during the monsoon (Chowdhury and Huque, 1996). It has been reported that overall 21% of rice straw is lost due to spoilage as a result of faulty storage and heavy rainfall in Bangladesh (M. A. Akbar, personal communication). The adoption of improved storage technique will certainly improve the keeping quality of rice straw available for feeding to livestock. It will also enable farmers to store rice straw for longer periods. Improved storage technique could also help to store rice straw during the rainy season and periods of flooding when livestock feeding can be a major problem. Considering the above points the present research was undertaken to know the existing practice of storage of rice straw, routes of straw losses and problems related to livestock rearing.

Materials and Methods

Keeping in view the objectives of the study, PRA was conducted in experimental areas. Four villages in Mymensingh District were selected purposively. Among 4 villages Rajpur and Garaikuti are in Muktagachha Thana, and Mothbari and Bhoradoba are in Trishal Thana. The government officials of respective Thana offices helped in selecting these areas. The experimental period lasts from January to March, 2001.

Climatic condition of the experimental sites: The climatic condition of the experimental sites is characterized by light rainfall during April- May and heavy rainfall during June-September. The soil is silt loamy to silty clay loamy and gray brown to dark gray. The agro-climatic condition of the experimental areas is shown in Table 1.

Baseline survey: A baseline information was collected through Participatory Rural Appraisal (PRA) using a pre designed questionnaire. PRA is a set of participatory and largely visual techniques for assessing group and community resources identifying and prioritizing problems and appraising strategies for solving them. However, PRAs were conducted to fulfill the following specific objectives for two groups of farmers in four selected villages of Mymensingh district. PRAs with cattle farmers aims to explore:

1. Feeding practices and storage facilities of animal feed specially rice straw.
2. Constraints to the production and safe storage of animal feed.
3. Opportunity for improving feed quality and availability.
4. Causes of straw losses during harvesting, processing and in stored condition.

Procedure for conduction of PRA: The multi disciplinary team of the BAU including two women facilitators conducted PRA in four selected villages. After selecting the target groups, the facilitators explained the specific objectives to the participants of respective group of farmers and women participants. Local educated persons, NGO and DAE personnel assisted in conducting PRA survey. Initially, team members from BAU visited the study areas and tested the proposed methodology with each respective group of farmers. In the first place, team members sat with the participating farmers, introduced themselves, and clearly stated the purpose and objectives of the visit. Team members discussed with participants of each villages the salient physical and biological features of the village e.g. topography, cropping system, cultivated crops, livestock rearing, storage of straw and feeding, systems roads and houses and other socioeconomic infrastructures and recorded these informations. After that the PRA participants mentioned the primary problems, intermediate

Table 1: Agro-climatic conditions of Trishal and Muktagachha

Experimental area	Agro-ecological zone	Soil texture and colour	Physiography	Climate		Drainage/Flooded
				Annual rainfall (mm)	Mean annual temp. (°C)	
Trisal and Muktagachha (Mymensingh)	9b	Silt loamy and silty clay loamy. Gray brown to dark gray	Most areas have broad ridges and basins. Relief is irregular. The difference in alleviation between ridge tops and basin centers usually is 2-5 meters.	2000-4000 (<15->40) $\bar{x}$ =2966	25.3	Shallowly flooded. Early and rapid flooding by run off from adjoining higher land when heavy pre-monsoon or early monsoon rainfall occurs locally. Other time flood level are controlled by flood level in the Jamuna.

Source: FAO-UNDP, 1988

Table 2: Village wise target group participation in the PRA

	No. of participants participated in the PRA				No. of session
	Small farm households		Medium farm households		
	Farmers	Women	Farmers	Women	
Muktagachha					
Rajpur	8	8	8	8	4
Garaikuti	8	8	8	8	4
Trishal					
Motbari	8	8	8	8	4
Bhoradoba	8	8	8	8	4
All villages	32	32	32	32	16

problems and finally the root causes of each problem. Before the session it was pre-designed the procedure of finding and ranking of the problems using Causal Diagram. In the second step, primary problems were scored by the selected farmers according to the severity of the problem. Each problem was assigned maximum of ten marks and the farmers allocate marks out of ten to each of the primary problem. The allocated mark of each primary problem was then divided into the intermediate causes according to their severity. Finally, root causes were identified by farmers and scored by adding the individual scores of all related intermediate causes. In the third step, the ranking of each root causes was made according to scores. After identification of the root causes of problems, ranking was made by summing up the scored value and then attempts were made to find out their solutions. Opinions of the participants were obtained in chalking out probable solutions of each problem.

Target group selection: Considering the majority and concentration of farm households, small and medium farmers were selected for conducting participatory rural appraisal (PRA). Secondly, one of the main criteria of selecting these farm households was that, only those farmers were selected who owned at least two cattle heads. For each household wives of respective group of farmers were also being included as participants of PRA to know their participation in cattle rearing and other household activities. Therefore, there were four groups of participants in each village and accordingly four individual PRAs were considered (Table 2). In each group there were 8 participants and in total 64 farmers and equally 64 women participated in PRA.

In all the selected villages, the different sizes of farm households were identified using their own criteria. Bearing in mind the objectives of PRA study, four groups of participants as shown in Table 2, were selected to conduct PRA. In each group of PRA sessions there were 8 participants and in total 64 farmers and equally 64 women participated in PRA. Table 2 and 3 show the details of target group segmentation.

Survey data analyses and presentation: The data information collected through PRA questionnaire were analyzed and presented in the form of tables, figures, flow diagram and scored causal diagram.

Results and Discussion

This is almost a new study in Bangladesh aspect since very limited work has been done relating rice straw losses and its impact on livestock rearing. So, this study has been conducted to collect information in that field.

Existing practices of storing rice straw: Majority of the farmers in the study areas cultivated rice at least twice a year, once in winter season (T. aman rice) and also in wet season (Boro rice). Very few of them cultivated Aus rice. Crop calendar indicating the sowing and harvesting time of different varieties of rice is shown in Fig. 1. After harvesting, the farmers thresh rice and dry up the straw in the sun for storing. Except rice straw, no other crop residues were stored by the farmers to feed their animal. After drying straw properly, they follow the traditional method of storage - making stacks on the ground in open area by putting layers of straw and making the shape like the dom of mosque. The stacks were not covered to protect it from rain - water damage. This

Table 3: Socioeconomic characteristics of target groups in selected villages

Small farmer	Own small size of land (<1.00 ha). Many of them (>50%) rented in land to make size of holding larger and to have more farm production. Few of them temporarily work as a day labourer to supplement their household income. About 60% small farmers own cattle heads 2-3 in nos. Some of them have only one, preferably a cow. Produce 2-3 times rice production is available for household consumption. Straw is the main feed for animal and its supply is available, in most cases, for 9-10 months. Farmers store rice straw in open place that cause damage and losses.
Medium farmers	Own land 1.01-3.03 ha. Some of them also rented in land. More than 80% farmers own cattle heads 2-4 in nos. Most of them (90%) produce sufficient amount of straw but open storage causes damage of straw. Produce 2-3 times rice in a year. Rice is a principal food and it is sufficiently available for consumption.
Women participants	Women of different farm households, most of them are housewives. They are actively involved in household activities particularly in cattle rearing, and processing and storing of rice straw.

Table 4: Rice growing season indicating sowing and harvesting period

Crop	Sowing period	Harvesting period
T. aman	Late June-September	Late November-January
Boro	December-Mid February	Mid April-June
T. aus	Mid March - Mid April	Mid July -August

Table 5: Farmers reported the causes of straw losses

Crops	% of straw damaged and losses from total amount produced	% of losses suffered from (considered spoilage amount = 100%)		
		Continuous raining	Less sun shine	*Others
T. aman	18	-	20	80
Boro	50	80	10	10
Aus	48	85	5	10

*Termite, rat, *anjona* (a reptile pest), poultry, birds and evaporated gas from the soil.

system of storage exposed straw to rain water on the surface area of the heap as well as to the pests like rodents etc. from the ground attached portion which seriously damaged the dried straw. In a previous study in Asia (Doyle *et al.*, 1986) and Bangladesh (Chowdhury and Haque, 1996) have also described that the farmers stored rice straw in stacks in open area. Moreover, Doyle *et al.* (1986) also indicated that stacks may be built under trees to give some protection; raised wooden platforms, polythene, corrugated iron or coconut tree leaves can also be used to improve storage condition.

Causes of straw losses: The sample farmers participated in the PRA programme and discussed and passed their views regarding damage and losses of straw from harvesting to storing. Three stages of straw losses as reported by PRA participants are shown in Fig. 1. In a previous study Tripathi *et al.* (1995) described that storage losses range from the shattering and loss of leaves, the most nutritious part of straw, leaching of soluble nutrients by rain, potentially large losses due to mould damage and bleaching by exposure to sun shine causing losses of nutrients.

Straw losses during harvesting: Usually Boro and T. aus are harvested during wet season as shown in Table 4. Due to excessive and continuous rainfall sometimes water stand in the crop field at the time of harvesting and in that case the farmers can collect straw partially. Secondly, because of the continuous raining, farmers can not make good harvest of rice which also causes loss of straw. Farmers reported that 8 and 10% straw of Boro and T. aus, respectively, was lost during harvesting.

Straw losses in processing: Fig. 1 and Table 4. show the crop calendar, and sowing and harvesting period of rice. Only T. aman was harvested in dry season but Boro and T. aus in wet season. During dry season, there was enough sunshine for drying straw which was not available in the wet season because of the frequent rainfall and the farmers faced serious problem of drying straw, consequently there was spoilage. That the estimated spoilage of Boro and Aus straw to be 25-23%, respectively which is also reported by Akbar *et al.* (1995). In dry season, farmers dried their harvested T. aman paddy in the field. At the time of drying straw grazing cattle and birds destroyed straw only a little quantity(2%). However, out of total losses of straw for Boro and Aus, more than 80%, (Table 5) and sometimes 98% (Akbar *et al.,* 1995) caused by continuous raining. Participated farmers reported that the spoilt straw was used for making compost with cow dung however, sometimes the less spoiled straw was used for feeding animals during crisis period. After feeding spoiled straw, animal health as well as milk production were affected.

Straw losses in time of storage: Both small and medium farmers stored rice straw in unroofed condition in open area and did not use any platform for storage. Accordingly, quality and safety of straw had been affected. Most of the farmers expressed their opinion that rain water damage the upper layer of straw stack, and poultry birds and *anjona* (a reptile pest) make losses and deteriorate the quality of straw (Table 6). Secondly, due to unplatformed storage, rat and termite also damaged the straw. Thirdly, evaporated earthen gas destroyed the bottom portion of stored straw. Adding all these causes farmers mentioned that estimated total loss might be 18-20%.

Problem ranking of storage of rice straw and rearing of livestock and the causes and recommendations for solution: As has been mentioned earlier that rice straw is the main feed for ruminants in Bangladesh and the farmers usually store rice in the open place and that causes damage and losses, and deteriorate the quality of straw. On the other hand, due to shortage of animal feed, cattle owners face serious problem of rearing livestock. Therefore, safe storage of rice straw and livestock rearing are interdependent and interrelated. Accordingly, these two issues were taken into account to identify the major causes and constraints of storage of rice straw and rearing livestock by small and medium farmers. However, to determine the scale and magnitude of problems and constraints of storage of rice straw and rearing livestock, the method of Causal Diagram was used. Among the group of PRA participants, both small and medium farmers were considered to discuss the problems and constraints they face in storage of straw and rearing livestock. Issues raised in discussion with the selected farmers of Rajpur, Garakuthi, Motbari and

Table 6: Farmers' experience of causes that affected the quantity of stored straw

Causes affecting quantity and quality of stored straw	Small farmers (%)	Medium farmers (%)	All farmers (%)	*% of stored straw losses
Rain water damaging upper layer of open stored straw	80	70	75	5
Damaged by poultry birds and *anjona*	90	95	93	8
Rat and termite damaging bottom portion of stored straw	60	70	65	3
Evaporated earthen gas and wet soil spoil bottom layer of piled straw	90	80	85	2

*Considered 100% in stored condition

Table 7: Root causes of problems resulting in losses of stored straw

Overall rank	Total scored	Root causes of problems and constraints
1	23	Poor management of farmers in storing straw (farmers follow traditional unroofed storing, and they are unconcerned and reluctant to improve management).
2	6	Lack of capital of farmers to take measures for protection of losses of straw

Table 8: Root causes of problems of rearing livestock

Overall rank	Total scored	Root causes of problems and constraints
1	10	Extensive and intensive cultivation of rice (left small land for other crops)
2	8	Lack of administrative control (in providing services of veterinary doctors and facilities of veterinary hospital, and security of cattle farmers).
3	5	Veterinary hospitals services are not available in villages
4	5	Poor management and losses of stored straw
5	1	Degradation of social security and stolen of cattle

Bhoradoba and estimated scoring were documented in Fig. 2 and 3, respectively. It may be noted here that the problems faced by small and medium farmers were almost same and also in the same scale, and accordingly their common problems and views are presented here together.

Scored Causal Diagrams on storage of rice straw and rearing livestock are presented in Fig. 2 and 3, respectively and their corresponding root causes are discussed in Table 7 and 8 The root causes of problems of storage of rice straw and rearing livestock and their recommendations for solutions are discussed below the Table 7 and 8, respectively.

In case of storage of rice straw the single most common solution for many problems as was recommended by the farmers was to improve storage system through better management.

To overcome the losses of stored straw management of storing should be improved. Polyethylene, old fishing net and other necessary materials should be used on unroofed storage of straw. Wooden or bamboo platform should be made in order to protect straw losses from earth surface heat and rodents. Low cost roofed storage might be introduced through extension and motivation of farmers and by training on structural design of roofed storage. Credit on simple terms and condition should be provided to the farmers for proper storage of rice straw.

To overcome the problem of rearing livestock, supply of green fodder to animals should be increased by introducing fodder crops without or with minor changes in the existing cropping system, as

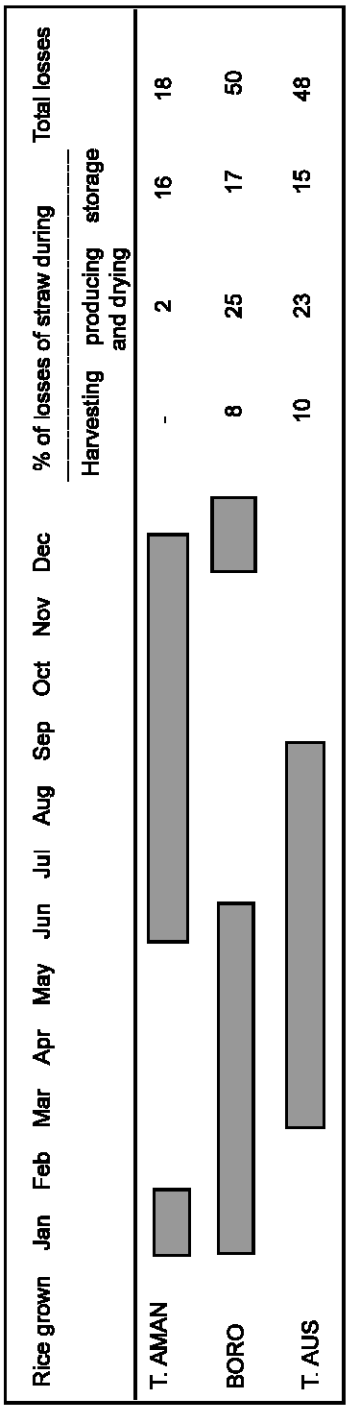

Fig. 1: Crop (rice) calendar and percentage of losses of rice straw

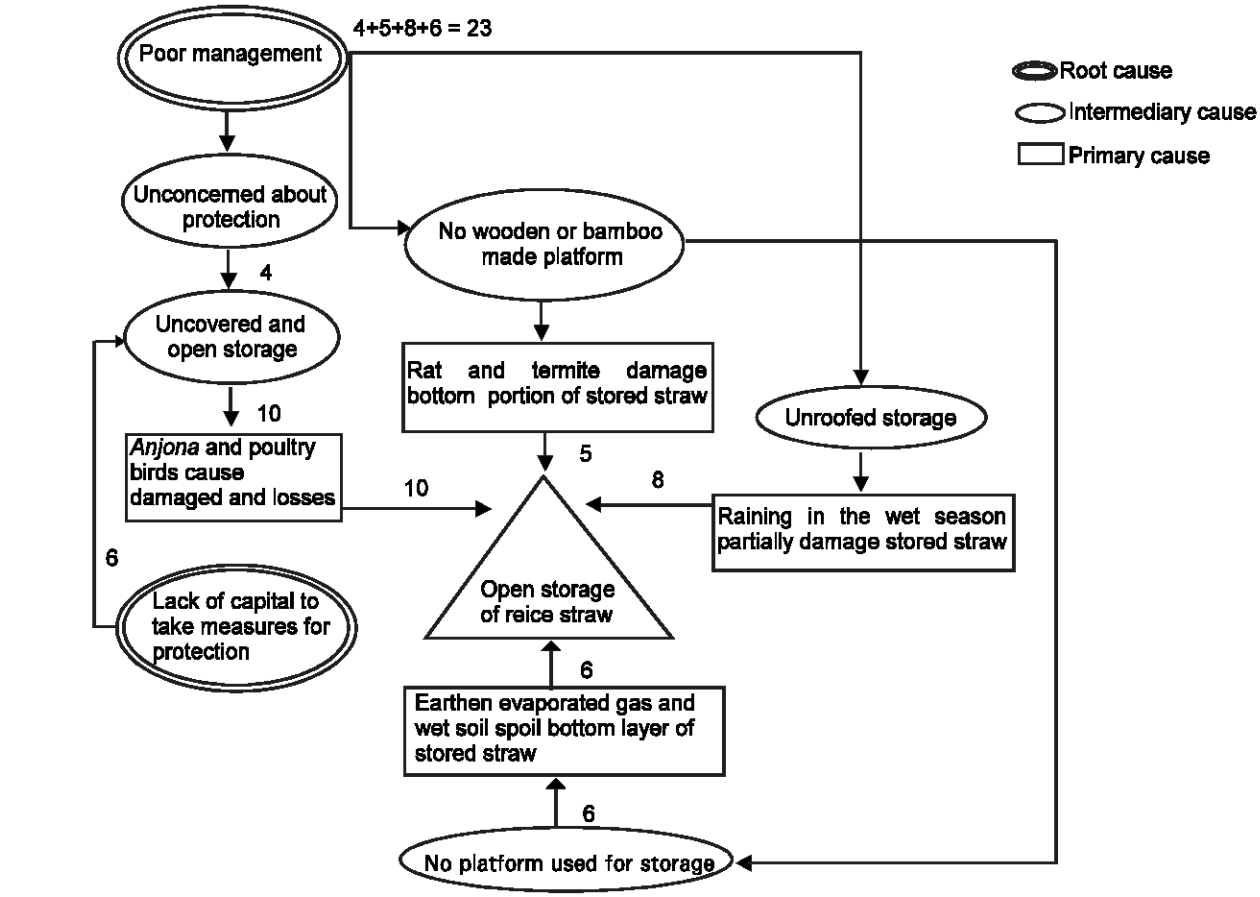

Fig. 2: Scored causal diagram on storage of rice straw in the study areas

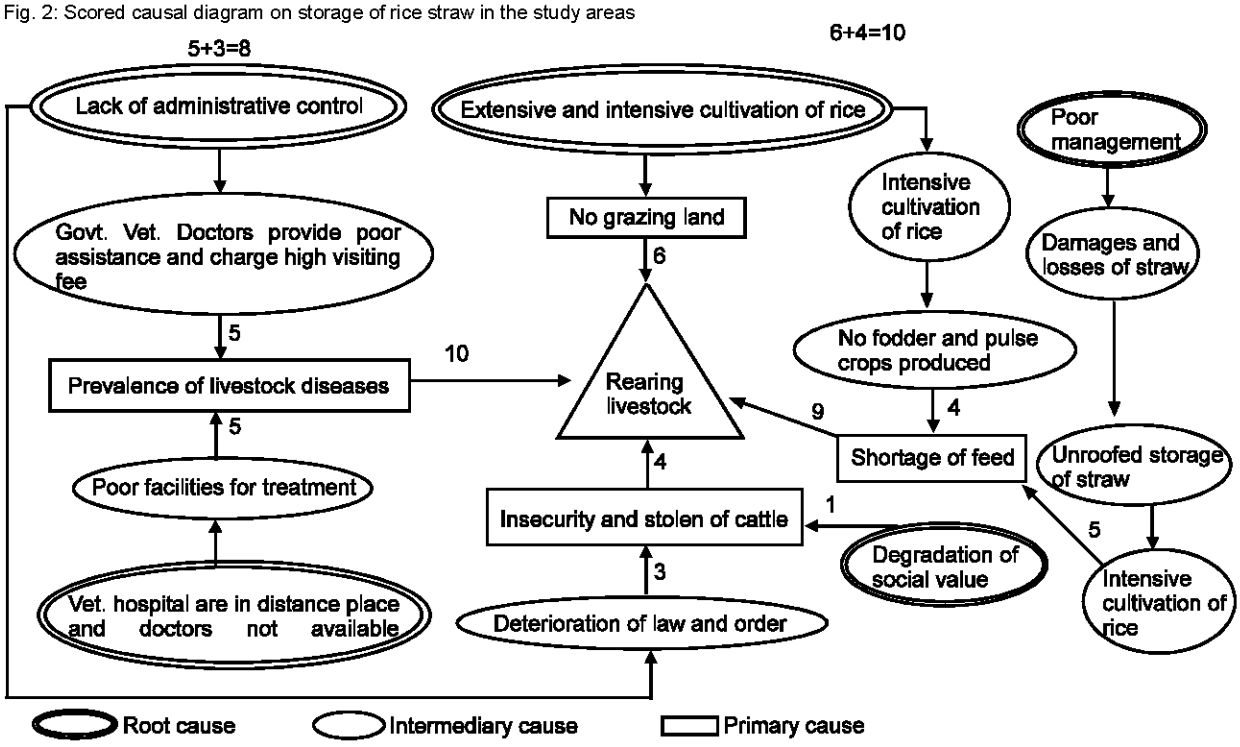

Fig. 3. Scored Causal Diagram on rearing livestock in the study areas

suggested by Akbar *et al*. (1995). In between T. aman and Boro rice, short duration legume fodder should be introduced. Disciplinary steps should be taken by the administration against irresponsible officials to ensure veterinary services to each farmer. Government should take measures to improve law and order situation and thieves of cattle should be punished. Training and motivation should be organised to develop social values and awareness of government veterinary doctors and other relevant officials.

It may be concluded that for improving seasonal availability and to conserve straw quality, improve storage technique is essential. Measures should be taken to protect straw losses by using low cost roofed storage.

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Islamic Fasting: An Effective Strategy for Prevention and Control of Obesity

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Abstract: A balanced and energy-restricted diet, exercise and behavior modification are the usual approaches used for obesity. Islamic fasting, which has the components of energy restriction and behavior modification, could be a safe nutritional approach for the prevention and treatment of obesity. For this reason, the effect of Islamic Fasting, an abstention from Foods, fluids and sex from dawn to sunset, on food intake, body weight and blood chemistry was studied in ten healthy adult male human subjects. Foods and Fluids intake before and in the first and fourth week of Fasting were recorded. Body weight of the participants was noted before and at the last day of Fasting. Blood samples before, in the second and fourth week of Fasting and two weeks after Fasting were collected. The daily reduction in energy (Food intake) ranged from 200-1500 Kcal with an average value of 857± 410 Kcal. During the four weeks of Fasting, loss in body weight ranged from 0.5-6.0 Kg with an average value of 3.2±1.7 Kg. There were no significant differences in glucose, total protein, triglyceride and total, HDL and LDL cholesterol in the blood samples collected before, during and after the Fasting. The data suggest that Islamic Fasting is nutritionally safe and could be used as an effective strategy for prevention and control of obesity

Key Words: Islamic Fasting, Safe Nutrition, Obesity

Introduction

Obesity is becoming a major nutritional problem particularly in the western countries. It is generally agreed that obesity is associated with significant morbidity and reduced life expectancy. Thus, in turn, can be related to the development of various other medical conditions such as hypertension, hyperlipidemia and type II diabetes. It is fortunate that these problems are themselves often best treated by weight reduction. Obesity, in addition to heredity, emerges from overeating and sedentary life style. Low calorie diets, behavior modification and exercise are the usual approaches used for treatment of obesity (Bennion, 1979; Kreitzman, 1989; Young, 1973).

A balanced energy-restricted diet is the most reasonable method for weight reduction. Ideally, the diet should be nutritionally adequate except for energy. The number of calories must be decreased to the point where the body mass mobilize fat stores to meet daily energy needs. The energy restriction should be maintained at level where weight loss is 0.5-2 Lbs per week. In such type of regimen, there will be no increase in ketone bodies in blood and thus, the side effects will be minimum. The caloric value of body fat is approximately 3500 Kcal/Lb. Thus, if a person reduces daily caloric intake by 500 Kcal the weekly deficit will be 3500 Kcal or 1 Lb. of weight loss (Sande and Mahan, 1984).

Exercise is not popular among most obese individuals. But it should be included in the weight control programs as physical activity is an adjunct to diet therapy, owing to its effect on body weight, body composition, appetite and metabolic rate. Exercise decreases body fat and increases muscle mass, and since lean body mass is more dense than the fat it replaces, body weight may not change at the initial stages of exercise. It appears that a minimum of 2 months is needed to obtain any reduction of adipose tissue with training programs, provided they are strenuous enough. Physical exercise may decrease appetite and obese person may profit in two ways, increased energy output with decrease energy input (Sande and Mahan, 1984).

Islamic Fasting could be a safe nutritional approach for prevention and treatment of obesity. The Fast imposes a temporary ban on food intake resulting into a less energy intake. The change in schedule of eating in the month of Fasting is really a behavior modification. Also the religious activities of muslims are particularly increased in this month due to special incentive for various acts of worship. Also an extra daily lengthy night prayer of Taraweeh is imposed in this month. Practically speaking, the fasting individuals in this month are at par with people who are doing moderate exercise (Kaandhlawi, 1928; Alfarooqi, 1984).

The time related ban on energy intake, change in eating schedule and increased religious activities may have an effect on the body biochemical and physiological functions (Fedail *et al*., 1982; Mustafa *et al*., 1978; Sulimani, 1988; Hussain *et al*., 1987; Gumaa *et al*., 1978; Sakar, 1975). The project was aimed at to see if food intake in the month of Fasting was changed; was Fasting nutritionally safe and could a safe nutritional strategy for obesity prevention and control programs.

Materials and Methods

The study was conducted in Ramadan the month of Fasting in the NWFP Agricultural University, Peshawar, Pakistan. Ten healthy Professors (age 21-59 years, mean 44±9) of the university volunteered for the study. The purpose, obligations and protocol of the study were explained to them. Daily food intake for 3 days before and 3 days in the first and fourth week of the Fasting were recorded by the participants in a questionnaire provided to them. Energy intake was calculated from food composition table (Zaka-ur-Rahman; Anis, 1988). The height and weight of the participants were taken one day before the Fasting and the weight was again taken at the last day of the Fasting, using the standard hospital scale. Blood samples before, in the second and fourth week of the Fasting were collected in clean centrifuge tubes. Blood samples before Fasting were collected after over night (10-12 h) fasting while during the month of Fasting, the blood samples were collected at mid day 10-12 h after Sahoor, the meal before dawn.

The blood samples were allowed to clot at room temperature for 15 minutes and then centrifuged at 5000 rpm for 10 minutes for separation of the serum. The serum were transferred to clean tubes and were analyzed for glucose, protein, triglyceride and total, HDL and LDL cholesterol using the standard procedures of Diagnostic Merck and Merck reagent kits (Darmstad, 1987). The serum glucose was determined by O-Toludine method, using 3306 merckotest reagents. Serum total, HDL and LDL cholesterol were determined by Leiberman - Burchard photometric method, using 3312 merckotest, and 14210 and 14992 precipitating reagents respectively. Serum total protein was determined by Biuret method using 3327 mercko test reagent. Serum triglyceride was determined by calorimetric method using Human reagent

Table 1: Effect of Islamic Fasting on Mean (±SD) Serum Glucose, Protein, Triglyceride and Total, HDL and LDL Cholesterol

Blood Parameters	Concentration		
	Before the Month of Fasting (N=10)	During the Month of Fasting (N=10)	[1]Mean(Normal Ranges)
Glucose (mmol/l)	4.56± 0.45	4.42 ± 0.39	5.3 (4.2-6.4)
Total Protein (mg/dl)	71.84 ± 6.98	70.50± 5.66	76.5 (66-87)
Triglyceride (mmol/l)	1.36 ± 0.31	1.35 ± 0.30	2.0 (1.71-2.29)
Total Cholesterol (mmol/l)	5.30 ± 0.78	5.26 ± 0.73	5.66 (5.17-6.18
HDL Cholesterol (mmol/l)	1.86 ± 0.27	1.84± 0.25	1.29 (1.06-1.52)
LDL cholesterol (mmol/l)	2.07 ± 0.43	2.03 ± 0.44	2.9 (3.9-4.9)

[1]The normal ranges are taken from the " randox Manual Procedures" Randox Laboratories Ltd., Diamond Rd, Crumlin, Co., Antrim, United Kingdom, BT29 4QY

kit. The average values of the blood constituents collected before and after the month of Fasting were compared with the values of blood constituents collected during the month of Fasting, using the Student T Test.

Results

The average daily energy intake before and during the month of Fasting was 2815±339 and 1958±384 Kcal respectively. The average daily reduction in energy intake was 857± 410 Kcal. The average body weight before and at the last day of the Fasting were 80.8±9.0 and 77.7±8.1 Kg respectively. The average loss in weight due to Fasting was 3.2±1.7 kg.

Serum glucose, protein, triglyceride and total HDL and LDL cholesterol are presented in Table 1. The blood constituents decreased during the month of Fasting, however, this decrease was not significantly different from the constituents of blood collected before the month of Fasting.

Discussion

Islamic Fasting is a religious obligation for all adult healthy Muslims. Children are exempted from Fasting. Sick individuals can delay the Fasting until they are healthy. Pregnant and lactating women, if their health or child is in danger, can postpone the Fasting to a time when they are out of that physiological state. Option to fast or delay to some other time is also given to those who are traveling in the month of Fasting. Menstruating women are not allowed to fast during their menstruating period. However, they have to make for these days when they are not menstruating. As Islamic Fasting is an ordain of Almighty Allah, Muslims observe the Fasting with full etiquette, precaution and devotion in Ramadan, the ninth month of Islamic Calendar which is based on lunar year. In this month they are abstained from foods, fluids and sexual activities from dawn to sunset, and they are required to pray every night a lengthy Taraweeh prayer for the whole month of Ramadan. Actually in Islamic Fasting, there is a shift in the eating schedule from day to night. There is a meal before dawn called Sahoor and a meal after the sunset called Iftaar. In this month the Muslims are almost restricted to the above two meals. Because they can eat after Iftaar up to Sahoor but practically they do not have time to eat after Iftaar as they have to pray the usual Maghrib and Isha prayers and also the lengthy Taraweeh prayer. Also they have to sleep too before getting up for Sahoor.

The ban on eating and drinking at day time and limited time for eating at night ensure a reduced food intake. Also the increased reward of worship in this month (11th) make the Muslims more engaged in recitation of Holy Quran, non-obligatory (Nafl) prayers and other religious activities. Also the extra every night lengthy Taraveeh prayer is a sufficient exertion on the fasting individuals in this month. These activities are almost at par with moderate exercise level.

In addition to the obligatory Fasting in the month of Ramadan, there are non-obligatory (Nafl) fasting too. These non-obligatory (Nafl) fasting can be observed any day throughout the year except on the first day of Shawal, on the 10th, 11th, 12th and 13th of Zulhaja, (the 10th and 12th month of Islamic Calendar respectively). Fasting on these 5 days are prohibited in Islam. It has been reported that the Prophet of Islam, Muhammad (Sallallaho Alaihe Wasllam) has observed non-obligatory (Nafl) fasting on every Monday and Thursday of the week, 3 days in each month on 13th, 14th, and 15th of the lunar month, on the 9th and 10th or the 10th and 11th of Muharram , on the 15th of Shaban , 6 days in Shawal after Eid-ul-Fitr and on the 9th day of Zulhijja (The Ist, 8th, 10th and 12th months of Islamic Calendar respectively). The non-obligatory Fasting sums up to some 15 days per month (Hussaini and Sakr, 1981). Many devoted followers of Islam observed these non-obligatory (Nafl) fast. The non-obligatory (Nafl) fasting adds almost up to 5 months in a year and this regime will prevent and control obesity.

In nutritional terminology, Islamic Fasting has the components of caloric cut in intake, behavior modification in terms of eating pattern and exercise in terms of increased religious activities. These components are the necessary steps to be used in any obesity prevention and control program. The obligatory Fasting along with the non-obligatory ones will save the individual from obesity and obesity related problems like cardiovascular, hypertension and diabetes mellitus. The author believes that Islamic Fasting is not for obesity prevention and control, but obesity prevention and control through Islamic Fasting is an additional benefit of the Islamic Fasting.

As observed in the present study, the daily energy intake was dropped from 2816 ± 339 to 1958 ± 384 Kcal which means that the average daily intake of energy was reduced by 857 ± 410 Kcal in the month of Fasting. This reduction in energy intake was expected as, in Fasting, the eating schedule is changed and the individuals have to adapt with the changed schedule. Also they have very limited time to eat. The adaptive mechanism of the body for preservation of water during Fasting may have an effect on food intake. Usually Fasting individuals are thirsty, and they drink a lot of fluids at the Iftaar time, leaving little room in their stomach for regular food. The cut of 857 ± 410 Kcal was a significant reduction in caloric intake that was enough to produce lipolysis, and hence a significant weight loss was observed in the participants. The average weight loss during the month of Fasting was 3.2 ± 1.7 kg. This reduction in weight is in the recommended range of weight loss i.e. 0.5-1.0 kg/week. (Sulemani, 1988) and Fedial *et al*., 1982) have reported a total reduction of 1.0 ± 0 .66 kg in the body weight during Ramadan. Their findings are in the support of our results.

Islamic Fasting is becoming the popular approach in Muslims

society for weight control as on one side it is a religious activity that will be rewarded in the Hereafter and on the other side a preventive measure against the health hazards particularly obesity.

The nutritional safety of Islamic fasting was evaluated by blood analysis for glucose, protein and lipid profile. The results are presented in Table 1. The participants remained healthy throughout the Fasting month and did not complain for constipation and other disorders. Though the levels of serum glucose, protein, triglyceride and total, HDL and LDL cholesterol dropped during Fasting but these values were not significantly different from those values obtained from blood samples collected before Fasting. This was expected, as Islamic Fasting is not a total starvation but a change in eating schedule. Mustafa *et al.* (1978) have reported that fasting individuals maintain good control of fluid and electrolysis. Fedail *et al.* (1982) have reported that Islamic Fasting has no profound effect on blood chemistry. The data suggest that due to its nutritional safety, Islamic Fasting is an effective approach to prevent and control overweight problem.

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Physicochemical and Cooking Properties of Some Fine Rice Varieties

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Abstract: The experiment was conducted to know the Physico-chemical and cooking properties of six fine rice varieties. Among the varieties, milling and head rice out-turn ranges from 64 - 70% and 61 - 82%, respectively. The highest milling out-turn (70%) was found in the variety Superfast and lowest in Khazar. On the other hand, head rice out-turn was the highest (82%) in Khazar and lowest (61%) in Bashmati PNR. Grain length and breadth of the varieties ranges from 3.6 – 6.5 mm and 1.7 – 3.7 mm, respectively. The highest length (6.5 mm) was found in Khazar and the highest length-breadth ratio were found in Khazar and Superfast. Lowest grain length (3.6 mm) and length-breadth ratio (1.3) were found in Badshabhog and Bashmati 4488, respectively. Amylose content of the varieties ranges from 18.6 - 28.0% and the highest protein (8.6%) was found in BRRI dhan28 followed by Badshabhog and Superfast. All the varieties contain more or less standard rate (7%) of protein. Maximum cooking time (25 min.) were required in the variety of Bashmati 4488 and minimum (14.5 min.) in Badshabhog. Elongation and imbibition ratio were greater than 1.3 and 4.0 respectively in all the varieties except Khazar. Lowest elongation ratio (1.2) was found in Khazar.

Key Words: Rice (*Oryza sativa* L.), amylose, rice varieties, protein

Introduction

Rice (*Oryza sativa* L.) is the staple food for the people of Bangladesh and will continue to remain so in the future. It provides about 75% of the calorie and 55% of the protein in the average daily diet of the people (Anonymous, 2002). After the achievement of sufficient yield in high yielding varieties, the demand for fine rice is increasing day by day both in home and abroad. The fine grain rice is relatively low yielding but has good demand in the market with relatively higher price. It is also used in preparing special dishes on special occasions. The rice millers prefer varieties with high milling and head rice out-turn, whereas consumers consider quality (Merca and Juliano, 1981). Yields of head rice vary depending on many factors such as variety, grain type, chalkiness, cultural practice, drying, storing and milling conditions (Wasserman and Calderwood, 1972; Witte, 1972; Adair *et al.*, 1973). To attract the consumers' attention, appearance of rice is important which depends on the shininess and chalkiness of the kernel. Size and shape are also important factor to consumer. Preference for grain size and shape vary form one group of consumers to another (Khush *et al.*, 1979). High income group of people in Bangladesh prefer long slender grain, where as, lower income group prefer bold grain (Anonymous, 1997). The amylose content of rice is considered as the main parameter of cooking and eating quality (Juliano, 1972). Amylose content, volume expansion, water absorption influences many of the starch properties of rice (Juliano, 1979; 1985). Cooking time is important as it determines tenderness of cooked rice as well as stickiness to great extent (Anonymous, 1997). Higher the imbibitions ratio of rice lower will be the energy content per unit volume or weight of cooked rice, as they will have more water and solid materials (Anonymous, 1999). High volume expansion of cooking is still considered to be the good quality by the working class people who do not care whether the expansion is lengthwise or crosswise. Urban people, on the other hand, prefer the varieties that expand more in length than in breadth (Choudhury, 1979). Fine rice may be graded as export quality rice with normal nutritional quality. Under the above circumstances, the present study was undertaken to analyze and evaluate the physicochemical and cooking properties of some fine rice varieties.

Materials and Methods

The laboratory experiment was conducted at Grain Quality and Nutrition Division of Bangladesh Rice Research Institute (BRRI), Gazipur from March to May 2002. For this purpose six fine rice varieties collected from Genetic Resources and Seed Division of BRRI. Out of the 6 varieties, 4 varieties namely, Superfast, Basmati 4488, Khazar and Basmati PNR were imported, Badshabhog, was a local aromatic and BRRIdhan 28 was a high yielding variety released by BRRI. The rough rice was dehulled by Satake rice mill. The resulting brown rice was polished for 75 second in a Satake grain-testing mill TM05. This polished rice was ground by a Cyclone sample mill. Milled rice out-turn was expressed as percent of milled rice. Slide Calipers was used for measurement of grain length and breadth. Milled rice was first classified into three classes based on length, long (>6 mm in length), medium (5-6 mm in length), and short (<5 mm in length). They were again classified into three classes, according to the length/breadth ratio; slender (ratio more than 3); bold (ratio 2-3); round (ratio less than 2) to determine size and shape. Amylose content was determined by the procedure of Juliano (1971) and alkali spreading value was determined according to the procedure of Little *et al.*, 1958. Protein contents were calculated from nitrogen and was determined by Micro Kjeldahl method. Volumes of cooked and milled rice were measured by water displacement method. Five gram of milled rice was placed in a graduated cylinder containing 50 ml of water and the change in volume was noted. For cooked rice volume 5 gm of milled rice was cooked and the cooked rice was placed in the same cylinder and the change in volume was measured. Cooking time was measured when 90% of cooked rice was totally gelatinized.

Results and Discussion

Physical properties of six fine rice varieties: The six tested fine rice varieties contained satisfactory milling out-turn range from 69-70% and only one variety, Khazar had 64% milling out-turn (Table 1). The head rice out-turn was the proportion of the whole grain in milled rice. It depends on varietal character as well as the

Table 1: Physical properties of some fine rice varieties

Variety	Milling out-turn (%)	Head rice(%)	Chalkiness (%)	Length (mm)	Breadth (mm)	Length/ Breadth	Size and shape ratio	Appearance
Superfast	70	71	Opaque	6.1	1.7	3.6	Long slender	Fair
Basmati 4488	70	79	White belly	4.7	3.7	1.3	Short round	Good
Khazar	64	82	Translucent	6.5	1.8	3.6	Long slender	Very good
Basmati PNR	70	61	White centre	6.3	1.9	3.2	Long slender	Good
Badshabhog	69	75	White centre	3.6	2.0	1.8	Short round	Good
BRRIdhan 28	71	70	Translucent	5.8	1.9	3.1	Medium slender	Very good

Table 2: Chemical properties of six fine grain rice varieties

Variety	Alkali spreading value	Amylose (%)	Protein (%)
Superfast	3.2 c	24.2 b	7.6 c
Basmati 4488	3.0 d	23.7 c	7.0 de
Khazar	3.1 cd	18.6 e	6.9 e
Basmati PNR	3.9 a	18.6 e	7.1 d
Badshabhog	3.6 a	20.3 d	7.9 b
BRRI dhan 28	3.8 a	28.0 a	8.6 a

Within column means followed by same letter (s) did not differ significantly at P<0.05.

Table 3: Cooking properties of six fine rice varieties

Variety	Cooking time	Elongation Ratio	Imbibition Ratio
Superfast	18.5	1.4	4.3
Basmati 4488	25.0	1.5	4.6
Khazar	17.5	1.2	4.3
Basmati PNR	16.0	1.3	4.6
Badshabhog	14.5	1.5	4.3
BRRIdhan 28	17.5	1.5	4.3

drying condition (Witte, 1972; Adair *et al.*, 1973). The head rice out-turn of all the tested varieties were not satisfactory. It varied from 61 - 82% (Table 1). A quality rice variety should have head rice out-turn at least 70%. Kernels of two varieties (Khazer and BRRIdhan 28) were translucent and looked very good in appearance. The variety Basmati 448 contained white belly and Badshabhog contained white center (Table 1). Only one variety (Superfast) had opaque kernel which is not a good varietal character.

All slender type and short bold rice are known as fine grain rice in the market and sold at higher price. Three varieties (Superfast, Khazar and Basmati PNR) had long slender grain. One variety BRRIdhan 28 was medium slender and other two varieties were short round. Length and breadth of the reported varieties ranges from 3.6 – 6.5 mm and 1.7 – 3.7 mm, respectively. The highest grain length and length breadth ratio were found in Khazar and Superfast followed by BRRIdhan 28 (Table 1).

Chemical properties of six fine rice varieties: Amylose content of the tested varieties varied ranges from 18.6 to 28.0% . The highest amylose (28 %) was estimated in BRRIdhan 28 followed by Superfast (24.2%) and lowest (18.6%) were in Khazar and Basmati PNR (Table 2). Amylose content of rice determines the hardness and stickiness of cooked rice. Amylose content higher than 25% gives non sticky soft or hard cooked rice. Rice having 20-25% amylose gives soft, and relatively sticky cooked rice (Anonymous, 1997). Alkali spreading value ranges from 3.0 to 3.9 of the tested varieties. The highest alkali spreading value (3.9) was found in Basmati PNR and the lowest (3.0) in Basmati 4488. Others four varieties remained between the above mentioned values (Table 2). Alkali spreading value and amylose content varied significantly by 5 % DMRT.

Protein content of rice is important from nutritional point of view. Protein content of the varieties ranges from 6.9 to 8.6%. The highest protein content (8.6%) was found in BRRIdhan 28 followed by Badshabhog. On the basis of nutritional value all the varieties contained sufficient amount of protein except Khazar which remain very little below the standard rate 7%. The protein content of fine grain rice is usually lower (Kaul, *et al.*, 1982; Dutta *et al.*, 1998) which is consistent with the findings of the present study.

Cooking properties of some fine rice varieties: Cooking time varied from 14.5 minutes to 25 minutes among the tested fine rice varieties. Only one variety Basmati 4488, having more than 20 minutes (i.e. 25 minutes) given comparatively hard cooked rice (Table 3). Elongation ratio of the fine rice varieties ranges from 1.2 to 1.5 (Table 3). It is an important parameter for cooked rice. If rice elongates more lengthwise it gives a finer appearance and if expands girthwise, it gives a coarse look (Anonymous, 1997). However, of the tested varieties only one variety (Khazar) had the elongation ratio less than 1.3 which was by no means desirable. The imbibition ratio all the tested varieties was more than 4 (Table 3) and it is considered as a positive quality in our country particularly by the lower income people as they want to fill up their belly without considering how much energy they will get from it. However, higher to imbibition ratio of rice, lower will be the energy content per unit volume or weight of cooked rice as they will have more water and less solid materials (Anonymous, 1997).

Conclusion: In general, fine rice in Bangladesh are low yielding and can not compete with high yielding varieties (HYV) of rice. Rice production technologies regarding HYV are now well developed and adopted by farmers in Bangladesh for maximum production. It is now time to emphasize to the improvement of the productivity of fine rice including its quality. It is urgently needed to characterize the fine rice as regard to their physico-chemical properties. Thus, the knowledge may be utilized for devising breeding strategy to their improvements for yield keeping intact their physico-chemical qualities.

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Effects of Concentrate Supplementation on Growth and Reproductive Performance of Female Sheep and Goats under Grazing Condition

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Abstract: An experiment was conducted to study the effect of concentrate supplementation on growth and reproductive performance of female sheep and goats under grazing condition. Six females each of sheep and goats aged about 6 months and weighing on average 9.80 and 9.77 kg respectively were studied for 224 days. Goats and sheep were allocated to two feeding regimes in a 2x2 factorial experiment. Feeding of animals (sheep and goats) with concentrate supplement significantly ($P<0.01$) increased DM (477.7 vs. 253.0 g/d) intake compared with those of the control group. The higher intake of DM resulted in significantly ($P<0.01$) higher live weight gain in animals of supplemented group than those of control group. However, between sheep and goats significant difference was observed in live weight gain ($P<0.01$) and DM intake ($P<0.05$). The results showed that certain reproductive parameters such as age at puberty, gestation weight and kid birth weight may be improved by supplementary feeding of concentrate. Therefore, feeding of grazing goats and sheep with concentrate supplement may be suggested to optimize growth performance.

Key words: Sheep, goat, concentrate supplementation, growth, reproduction

Introduction

Goats and sheep are economically important livestock to the poverty stricken village people in Bangladesh. The country has 35.6 million goats and sheep representing 58.8% (96.7% goat alone) of total livestock population and yielding 119 thousand metric tons (97.5% goat meat) of meat annually, which accounts for 28.7% of total livestock meat (FAO, 1997). In Bangladesh government statistics (FAO, 1992) indicate a current intake of animal protein of 2.0 g per capita per day, which is far below the FAO recommendation of 28 g per day. As a result adult people face chronic under- nutrition and children suffer from protein deficiency. Therefore, priority has to be given to improve the productivity of goats and sheep in order to meet present protein requirements of the country. Black Bengal goats are highly prolific and reputed for quality meat and skin production throughout the world. The genetic potentialities of these goats are deteriorating day by day due to indiscriminate breeding, lack of improved feeding and management practices. Sheep, another useful animal, can easily be maintained under rural conditions because of their ability to adapt to harsh environment, poor management and feeding practices. In our country, goats and sheep are mainly kept by the poor farmers and distressed women in extensive system under ranged condition without any supplementation. This system of production causes reduced growth rate and poor reproductive performance, which in turn results in severe economic losses. Previous studies (Kochapakdee *et al*., 1994a; Mahajan *et al*., 1976) have reflected the importance of concentrate supplementation on growth and productivity of goats and sheep. They also reported that grazing alone may not be sufficient for optimizing live weight gain and wool production. However, no comparative study has yet been done on the production characteristics of goats and sheep using available feed resources in our country. Therefore, the present experiment was designed to study the effects of supplementing concentrate on growth and reproductive performance of female goats and sheep raised under grazing condition.

Materials and Methods

Location and climatic condition: The experiment was conducted at the Bangladesh Agricultural University Animal Nutrition Field Laboratory, Mymensingh, for the period of 224 days during September 1998 to April 1999. The region has a subtropical humid climate with an average annual rainfall of 238.4 cm. and having a dry period extending from October to March with marked incidence of rainfall during July to September (Weather Yard, 1998, BAU Station).

Pasture establishment and management: A grazing land of 0.3 hectare was surrounded by strong fancy materials and this area was developed and pasture was established for raising goats and sheep during day. Naturally growing grasses available in the grazing land were collected and identified as *Axonopus compresus* (Carpet grass), *Panicum repens* (Banchina grass), *Imperata cylindrica* (Ulu grass), *Cynodon dactylon* (Durba grass) and *Cyperus rotundus* (Mutha grass). Irrigation (when it was needed) and fertilizer (urea 50 kg/ha) was applied.

Animals, diets and their management: Twelve female animals were used in this experiment. Six animals, each of sheep and goats aged about 6 months and weighing, on average, 9.80 and 9.77 kg respectively. Animals were blocked into three groups according to live weight and then assigned at random to two feeding regimes (control and supplemented group) in a 2x2 factorial experiment. The animals were than allowed 3 weeks to adapt to the experimental conditions prior to the commencement of the study. A skilled shepherd was engaged to rear the animals throughout the experiment. Identical housing, health care and sanitary measures were provided to all goats and sheep. The drug Fasinex, Ralnax, Novartis (Bangladesh) Ltd. was administered to the animals as routine anthelmintic. Goats and sheep were allowed to graze for 7.0 hours daily (08:00 to 12:00 and 14:00 to 17:00 h). In addition to grazing, the animals in supplemented group received a measured quantity of concentrate mixture consisting of wheat bran, rice polish and soyabean meal. The supplemental diet was formulated to contain an estimated ME concentration of 10.8 MJ and CP content of 170 g per kg DM. Concentrate mixture was fed daily at night. Fresh water was freely available at all times. Feed ingredients used in formulating supplemented diets and grass samples collected from the grazing land were subjected to chemical analysis following the method of

Table 1: Chemical composition of different grasses available in the grazing land

Parameter	Grass species						SEM	Level of significance
	Axonopus compressus	*Panicum repens*	*Imperata cylindrica*	*Cynodon dactylon*	*Cyperus rotundus*	Mixed grass		
DM (g/100g sample)	18.83^{c}	21.73^{bc}	25.93^{ab}	28.27^{a}	20.40^{c}	20.70^{bc}	1.57	*
Chemical composition (g/100gDM):								
CP	11.50	9.90	9.80	10.27	12.27	10.33	0.62	NS
CF	23.33^{cd}	29.80^{ab}	30.83^{a}	22.27^{d}	21.93^{d}	26.53^{bc}	1.19	**
EE	1.70	1.10	3.30	1.01	1.85	1.25	0.56	NS
NFE	53.94^{ab}	51.80^{abc}	47.92^{c}	55.88^{a}	52.36^{ab}	50.13^{bc}	1.26	*
OM	89.37^{bc}	92.23^{a}	92.33^{a}	90.60^{b}	88.53^{c}	89.47^{bc}	0.44	**
Ash	10.65^{ab}	7.74^{c}	7.66^{c}	9.41^{b}	11.46^{a}	10.56^{ab}	0.43	**

^{a,b,c,d}Data having dissimilar superscripts differ significantly (P<0.05); NS= Not significant; *P<0.05; **P<0.01

Table 2: Effect of concentrate supplementation on live weight change and dry matter intake of sheep and goats during the experimental period

Parameter	Sheep		Goats		SEM	Significance of contrast#		
	Control group	Supplemented group	Control group	Supplemented group		S	C	SC
Live weight gain (g/d):								
0-42 d	9.11	2.78	-6.34	31.33	7.81	NS	NS	*
43-84 d	15.08	36.13	-5.55	7.95	4.98	**	**	NS
85-126 d	-44.03	-4.37	-8.74	1.19	14.17	NS	NS	NS
127-168 d	-5.93	18.63	26.58	-2.76	9.67	NS	NS	*
169-210 d	29.77	39.67	26.58	39.70	11.98	NS	NS	NS
211-224 d	-9.53	-5.93	26.20	21.43	14.3	NS	NS	NS
Dry matter intake (g/d):								
0-42 d	266.7	365.3	201.0	401.7	12.6	NS	**	*
43-84 d	283.3	447.7	206.7	427.3	16.7	*	**	NS
85-126 d	280.0	421.0	206.3	425.7	16.9	NS	**	NS
127-168 d	297.7	505.0	226.7	495.3	16.7	*	**	NS
169-210 d	299.7	507.3	239.7	526.3	14.9	NS	**	*
211-224 d	314.7	534.0	252.7	549.0	18.2	NS	**	NS

#Contrast: S= Main effects between sheep and goats; C = Main effects between control and supplemented group,
SC= Interaction between main effects; NS= Not significant; *P<0.05; **P<0.01

Table 3: Effect of concentrate supplementation on reproductive parameters of sheep and goats*

Parameter	Sheep		Goats	
	Control group	Supplemented group	Control group	Supplemented group
Number of pregnant animals	1	2	1	2
Gestation length (days)	-	-	143	144
Litter size*	2	-	1	1
Percentage born alive	50	-	100	100
Birth weight of kids (kg)	1.15	-	0.55	1.45
Sex of kids	1 male +1 female	-	Female	Female

*Data presented here were not statistically analysed.

AOAC (1980).

Measurement of live weight and reproductive parameter: Live weight of sheep and goats was recorded initially and thereafter at 14-day intervals throughout the experimental period. During the time of kidding, weights of individual kids and dam were also recorded. The animals were weighed at 7:30 hours prior to access to the grazing land. Adequate management was provided for experimental animals to detect oestrus. The oestrus symptoms in goats were identified by visual observation and animals in oestrum were served by Balack Bengal buck towards the end of oestrus period. But in case of sheep, a ram was kept along with the ewes to allow natural service, as it was difficult to detect oestrus in sheep. Care was taken for pregnant animals and gestation weight gain was recorded. Age at puberty, date of service, gestation period, litter size, sex and birth weight of kids were also recorded.

Statistical Analysis: The experimental data related to growth performance were analysed using "MSTAT" statistical programme to compute analysis of variance (ANOVA) for a 2X2 factorial experiment. Data for herbage yield and chemical composition of

grasses were analysed following Randomized Block Design (RBD) and Duncans New Multiple Range Test (DMRT) was done to identify significant difference among the treatment means.

Results and Discussion

Chemical composition of grasses: The chemical composition of different grasses available in the grazing land is shown in Table 1. It is revealed that *Cynodon dactylon* and *Imperata cylindrica* contained significantly (P<0.05) higher DM than the other grasses. However, difference between *Cynodon dactylon* and *Imperata cylindrical* was not significant. The CP content of different gasses did not vary significantly (P<0.05). The highest CP content was observed in *Cyperus rotundus* (12.27%) and lowest in *Imperata cylindrical* (9.8%). Reza and Zaharaby (1994) reported that CP content of *Cyperus rotundus* collected from mustard field was 12.53%, which is similar to the present findings. Significantly (P<0.05) variable quantity of soluble carbohydrate (NFE) was recorded in different grasses. *Cynodon dactylon* (55.88%) contained significantly (P<0.05) higher amount of NFE compared with *Imperata cylindrica* (47.92%) but similar amount of NFE content was reported for other grass species. Among the proximate components, there were significant (P<0.01) differences in CF, OM and ash contents of different grasses. The result indicated that except *Panicum repens*, CF and OM contents in *Imperata cylindrica* were significantly (P<0.01) higher than the other grasses. In an Indian report, Ranjhan (1980) indicated that *Imperata cylindrica* contained similar amount of OM (92.2%) but higher CF content (39.7%) than that recorded in the present study. The variation in chemical composition reported in the literature for the same species of grass may be due to differences in soil fertility, stage of maturity, light intensity, season and other macro and micro environmental factors (Ranjhan, 1980).

Growth performance of sheep and goats: The mean values for live weight gain and dry matter intake of sheep and goats between 1 and 32 weeks of the experiment are shown in Table 2. It is evident that DM intakes were significantly (P<0.05) higher in sheep than that in goats only during the period between 43-84 days and 127-168 days of the experiment. Huston *et al.* (1988) reported that, with low quality forage, intake was lower and digestibility of potentially digestible DM was higher in goats compared with sheep. The average daily live weight gain recorded in the supplemented group during 43-84 days of the trial was significantly (P<0.01) higher (22.0 vs. 4.76 g/d) than that observed in the control group. Similarly, during that period sheep gained significantly (P<0.01) higher live weight (25.7 vs. 1.2 g/d) than that of goats irrespective of feeding regime. There were significant interactions between animal species and feeding regimes for live weight gain and dry matter intake during 0-42, 127-168 and 169-210 days of growth trial. These results suggest that the effect of supplementing concentrate on DM intake was higher in goats than that in sheep.

Reproductive parameters: Some reproductive traits of female sheep and goats raised under two feeding regimes (control or supplemented group) have been presented in Table 3. During the experimental period the average gestation length recorded in this study for goats was 143.5 days. In a study with Black Bengal goats, Husain (1993) reported a gestation length of 144.93 ± 0.29 days, which is similar to the present finding. Data for gestation length was not available for sheep because it was difficult to detect their oestrus symptoms. Average birth weight of kids (1.45 vs. 0.85 kg) was higher in supplemented group than control group and sheep produced lambs of higher birth weight (1.15 vs.1.00) than goats. A marked difference was observed in kids of control and supplemented group. However, Kochapakdee *et al.* (1994b) reported that supplementary feeding did not significantly affect either kid birth weight or weight gain in the first 6 weeks after birth. As the study suffers from adequate information, it is difficult to draw a precise conclusion on reproductive traits.

Conclusion: The results showed that concentrate supplementation improved growth rate of goats and sheep under grazing condition. However, animals lost live weight without supplementation under the same feeding regime. Therefore, feeding of grazing goats and sheep with concentrate supplement may be suggested to optimize growth performance. Further studies with different levels of concentrate supplementation may be conducted using large number of animals for a longer period to get more detailed information related to reproductive performance.

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Effect of Serum Albumin Level (at Admission) on the Overall Outcome of the Treatment of Childhood Standard Acute Lymphoblastic Leukemia

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This research was designed to study the impact of malnutrition based upon anthropometric measurement (MAD) and malnutrition based upon visceral protein level (MVP) on hospitalization stay, capability of patient to receive full dose treatment and overall outcome of childhood standard acute lymphoblastic leukemia in the developing countries

The majority of children on earth are to be found in the third world, many of them malnourished members of impoverished families. Thus the effects of nutritional status (NS) on the therapeutic response of children with cancer are obviously relevant.

In Pakistan more than 80% children are malnourished and more than 51 % are moderate to severe malnourished (UNICEF Children World, 1996), Which might be a vital poor prognostic factor for lower event free survival and outcome, even when aggressive protocols were used. As all other cancer acute lymphoblastic leukemia is also a catabolic state and patient and nurture on the behalf of the patients nutritional status.

In a country, where more than 50 % children are moderate to severe malnourished, it is very difficult to keep the optimal patient's nutritional status. Latest improvement in overall disease free survival is only been possible by the use of aggressive protocols in the developed countries. The tolerance of these aggressive protocols based upon the nutritional status of the patients. With a prevalence of 50% moderate to sever malnutrition it is very difficult to induct the same level of the chemotherapeutic dosages. Reduced induction of the drugs ultimately Leeds to the poor disease free survival and lower morbidity. This study was conducted to determine the effect of serum albumin level (at admission) on the overall outcome of the treatment of standard acute lymphoblastic leukemia according to the FMB protocols.

Posttest- randomized control group was designed to study the effects of malnutrition classified based upon anthropometric data MAD (Weight, height for age) and malnutrition classified on the bases of visceral protein (Koskelo *et al*., 1990; 1991; Yu-Le and Kuribidla, 1994) MVP (serum total protein and Serum albumin) levels (Ross Laboratories, 1978; Wahling and Georgieff, 1995) during the stay in the hospital, tolerance of the treatments doses and overall outcome during the course of treatment according to FMB protocols. To get a homogenous group of the patients, all patients were inducted in the study that registered in the Pediatric Hematology and Oncology Department for treatment.

All patient who were <02 and above 12 years, previous treated, were excluded from the study. Patients with standard ALL, age below 12 and above 02 years, newly diagnosed untreated, registered with the department for treatment were included in the study.

Total number of patients	:	70	
Patients with (ALBUMIN) Grade I	:	28	
Patients who complete treatment and alive	:	27	96%
Patients who relapsed but alive	:	00	
Patients who expired	:	01	4%
Total number of patients	:	70	
Patients with (ALBUMIN) Grade II	:	15	
Patients who completed treatment and alive	:	05	33%
Patients who relapsed but alive	:	03	20%
Patients who expired	:	07	46%
Total number of patients	:	70	
Patients with (ALBUMIN) Grade III	:	24	
Patients who complete treatment and alive	:	00	00%
Patients who relapsed but alive	:	01	4%
Patients who expired	:	23	96%
Total number of patients	:	70	
Patients with (ALBUMIN) Grade IV	:	03	
Patients who complete treatment and alive	:	00	00%
Patients who relapsed but alive	:	00	00%
Patients who expired	:	03	100%

The patients with Grade I serum albumin having good overall outcome. Ninety six percent patients completed their treatment and are alive and no patient relapsed. The expired patient was only one. The patients with Grade II, 33% patients completed their treatment and are alive. The percentage of relapsed is 20% and 46% patients expired. A marked decrease in overall outcome observed in patients with Grade III serum albumin level of 2.5 – 2.00 mg/dl. No patients completed their treatment and are alive. Ninety six percent patients expired during the treatment of standard acute lymphoblastic leukemia. One patient relapsed.

The results are worst in patients with serum albumin level below 1.9 mg/dl Grade IV. All patients expired during the due course of the treatment according to the FMB protocols. Data and results showed that serum albumin has significant factor for overall outcome of the treatment of standard acute lymphoblastic leukemia of childhood.

The serum albumin level below 3.00 mg/dl Leeds to very low prognosis and outcome of the treatment for standard acute lymphoblastic leukemia (Koskelo *et al*., 1991; Lobato-Mendizabal *et al*., 1989). The present study concluded that over all recovery above 80 % is only achievable if the patient's serum albumin level is above 3.00 mg/dl.

The determination of nutritional status on the basis of visceral protein markers (Koskelo *et al*., 1991; Lobato-Mendizabal *et al*.,1989; Lobato-Mendizabal and Ruiz-Argulles, 1990; Marin-Lopz, 1991) especially serum albumin level are most significant factor for the prognosis than the nutritional status determination on the basis of the anthropometry (weight, height). As Weir *et al*., 1998 Suggested that nutritional status at diagnosis, defined on the basis of the body mass index, in developed countries, has no effect on the prognosis in acute lymphoblastic leukemia and it

should not be considered as a prognostic factor, but in under developed countries the results are entirely different. In developed countries the incident of the malnutrition is very low.

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