A STUDY ON TIME TRENDS IN PRODUCTIONAND CONSUMPTION OF MILLETS IN GUJARAT, CONSUMPTION PATTERN OF MAJOR AND MINOR MILLETS IN SELECTED HOUSEHOLDS OF URBAN VADODARA AND DEVELOPMENT OF MILLET BASED RECIPES FOR PREVENTION OF NCDs.

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B.Sc (Hons)

Food Nutrition and Dietetics

A study on time trends in production and consumption of millets in Gujarat, consumption pattern of major and minor millets in selected households of urban Vadodara and development of millet based recipes for prevention of NCDs.

A dissertation submitted in partial fulfillment of the requirements for the degree of Master of Science (Dietetics)

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CERTIFICATE

This is to certify that the research work presented in this thesis has been carried out independently by Ms. Divya Negandhi under the guidance of Dr. Hemangani Gandhi in pursuit of Master's degree in Foods and Nutrition (Dietetics) and this is her original work.

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Divya Negandhi

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ABBREVATIONS

AERC- ARGO ECONOMIC RESEARCH CENTRE

COPD- CHRONIC OBSTRUCTIVE PULMONARY DISEASE

CU – CONSUMPTION UNIT

CVDs- CARDIOVASCULAR DISEASES

DALYs- DISABILITY ADJUSTED LIFE YEARS

FAO – FOOD AND AGRICULTURAL ORGANIZATION

FAOSTAT- FOOD AND AGRICULTURE ORGANIZATION CORPORATE STATISTICAL DATABASE

FIAN- FOOD FIRST INFORMATION AND ACTION NETWORK

GABA- GAMMA AMINO ACIDS

GI- GLYCEMIC INDEX

GOI- GOVERNMENT OF INDIA

HDD- HOUSEHOLD DIETARY DIVERSITY

HDL- HIGH DENSITY LIPOPROTEINS

ICRISAT- INTERNATIONAL CROPS AND RESEARCH INSTITUTE FOR THE SEMI ARID TROPICS

LDL – LOW DENSITY LIPOPROTEIN

MHA- MEGA HECTARE

MNT- MEDICAL NUTRITION THERAPY

MOHFW- MINISTERY OF HEALTH AND FAMILY WELFARE

NCDs- NON COMMUNICABLE DISEASES

NFSA- NATIONAL FOOD SECURITYACT

NFSM- NATIONAL FOOD SECURITY MISSION

NIN- NATIONAL INSTITUTE OF NUTRITION

NNMB – NATIONAL NUTRITION MONITERING BUREAU

NSSO- NATIONAL SAMPLE SURVEY OFFICE

PDS- PUBLIC DISTRIBUTION SYSTEM

PUFA- POLY UNSATURATED FATTY ACIDS

VMSS- VADODARA MAHANAGAR SEVA SADAN

WHO- WORLD HEALTH ORGANISATION

ABSTRACT

ABSTRACT

Background: Millets are known as nutritious food grains which are high in nutritional value compared to other cereal grains and provide many health benefits against chronic diseases.

Objectives: The broad objective of the study was to document the time trends in production of millets in Gujarat, its consumption pattern in urban Vadodara and development of recipes from millets to prevent NCDs.

Methodology: The study was carried out in three phases. The first phase focused on the documentation of time trends in millet production and consumption in India and Gujarat. The second phase focused on the consumption pattern of millets among the urban households of Vadodara city. The third phase focused on development of recipes from selected millets to prevent NCDs.

The documentation of time trends of millet production and consumption was done using secondary data source like agricultural reports such as Agricultural statistic reports, NNMB reports and scholar articles. To assess the consumption pattern of millets, 100 households from four different zones of Vadodara were surveyed with pre tested semi structured questionnaire Background information, consumption pattern of millets, frequency of millet consumption was taken for all the 100 households. To promote millet consumption, 6 different millets were selected based on awareness, taste and availability of them in Vadodara and five different recipes were developed considering the guidelines for NCD prevention.

Highlights of the results:

Review on time trends in production and consumption of millets showed decreasing trend. Bajra is the mostly grown millet of all other millets in Gujarat. Regarding millet consumption in urban Vadodara, it was found that none of the households consumed millets on daily basis. Only 30% of respondents consumed bajra once a week whereas only 23% of them consumed jowar once a month. Consumption of no other millets was reported except moriyo during fasting days.

Conclusion: It can be concluded that production and consumption of millets is showing decreasing trends over the years regarding its consumption of millets, among urban households also regular consumption of millets was not reported by the households. It was thought worthwhile to analyze millet consumption, was reported by the households with presence of co-morbidities in the family, age, education, occupation status of the respondent. It was found that all most all the respondents reported that their family members with co-morbidities like high blood pressure and diabetes consume millets. However frequency of regular consumption of millets was not reported. With regards to age, years of education and occupation status did not show much difference in consumption of millets. There was association between prevalence of co-morbidities in the households and consumption of millets. There is a need for health promotion activities to promote consumption of millets on regular basis by the community.

INTRODUCTION

INTRODUCTION

Millets also popularly known as nutri-cereals or coarse cereals, they are nutrient dense group of small-grained cereals which are largely cultivated in developing countries. They are used as both fodder and food grains. They are cultivated in extreme weather conditions and low rainfall and low fertile soil areas, making them contributors to food security in India. In spite of millets cultivation conditions they are high in nutrition and provide many health benefits against many diseases. They are gluten free and rich in minerals and vitamins, consumption of millets helps in decrease in triglycerides, inflammatory markers like C- reactive proteins which help in prevention from cardiovascular disease and its complications. Millets are comparatively rich in dietary fiber then other cereals. This dietary fiber has the ability to provide bulk and have water absorption property. This helps in increasing the transit time of food digestion in the body which helps in reducing the risk of inflammatory bowel disease and other gastro-intestinal problems.

Millets are traditional food grains consumed in India. The year 2018 was celebrated as "The Year of Millets" in India and the year 2023 is declared as "International Year of Millets" by Food and Agricultural Organization. All the awareness and promotions of millet show the importance of millet consumption.

There are 2 types of millets, Major millets and Minor millets differentiated based on grain size and area in which they grow. Pseudo millets have the same nutritional properties as of major and minor millets but belong to different botanical family.

Millets	Common name	Regional name
Major millets		
Pearl millet	Bajra	Bajri
Sorghum	Jowar	Jowari, Juvar, Jondhala
Finger millet	Ragi	Nagli,Bavto, Nachni
Minor millets		
Foxtail millet	Kakum	Kang, Rala
Little millet	Kutki, Shavan	Gajro,Kuri, Sava,Halvi,Vari
Kodo millet	Kondon	Kodra
Barnyard millet	Sanwa	Bhagar
Proso millet	Cheena, Barri	Cheno, Vari
Pseudo millets		
Amaranth	Ramdana, Rajgira	Rajgaro, Cavali biya
Buckwheat	Kuttu	Biyam satheno dano, Bataravhita
Quinoa	Quinoa	Quinoa

Major millets

Pearl millet

India is the largest producer of pearl millet and major states producing pearl millet are Rajasthan, Maharashtra, Haryana, Gujarat and Uttar Pradesh. Pearl millet also known as bajra consists high proportion of proteins and lipids. It is rich in dietary fiber which increases the transit time of food in gut. Hence reduces the risk of inflammatory bowel disease.

Sorghum

Sorghum is an important tropical cereal food, feed and fodder crop. It is an important grain and forage crop of semiarid regions due to its high adaptability and suitability to rain-fed low input agriculture. It is one of the most widely grown dry land food grain in India. Sorghum also known as jowar is rich in B vitamins, and minerals. Major portion of sorghum protein is prolamin which has feature of lowering digestibility than other cereals while cooking.

Finger millet

Finger millet which is commonly known as ragi is the richest source of calcium and sulphur rich amino acids. It has high antioxidant activity. Ragi is the staple food for many hilly regions of the country. It is used as both grains and fodder. It also has excellent malting properties and are widely used as weaning foods.

Minor millets

Foxtail millet

Foxtail millet also known as Italian millet generally grows in rain fed areas in India. It provides a host of nutrients has a sweet nutty flavor and is considered to be easily digestible and allergic free grains. Foxtail millet is rich in protein and contains minerals like copper and iron.

Little millet

This millet has small and rounder grain than other millets. They are high in iron and antioxidants and help in prevention of constipation and other stomach related problems as they contain about 38% of dietary fiber.

Kodo millet

Kodo millet is a highly drought resistant crop and coarsest grain of all grains. The seed coat should be removed before consumption. Kodari contains high amount of lecithin and is an excellent for strengthening of the nervous system. It is rich in niacin $B_{3,}$ pyridoxine B_6, and folic acid. Some studies have suggested that kodari can be consumed as a substitute to rice for diabetic patients.

Barnyard millet

Barnyard millet contains antioxidants such as gamma amino acids (GABA) and beta-glucan which help in reducing blood lipid levels. It is also rich in iron and fiber. It is commonly known in the Himalayan region and is grown as both for food and fodder purpose.

Proso millet

The millet is quite known for its short, 60 days grain producing after planting. It has a good source of essential amino acids compared to wheat and is cheaper source of manganese compared to other sources such as nuts and spices. It is also rich source of calcium, helps in maintenance of bone health.

Pseudo millets

Amaranth

Amaranth also commonly known as rajgira is high in magnesium, phosphorus, potassium, iron and calcium. It is good source of protein as it contains lysine, also rich source of dietary fiber and phytosterols which helps in lowering cholesterol levels in the

body. Rajgira has anti hypertensive and cancer preventive properties due to presence of lunasin- like peptide and other bioactive peptides.

Buckwheat

Buckwheat mostly consumed in northern part of the country is rich in polyunsaturated essential fatty acid (linoleic acid), high in soluble fiber and is a good source of minerals like zinc, manganese and copper compared to other cereals. Buckwheat contains a bioflavonoid rutin known to help in maintaining of blood pressure and also possess anti –carcinogenic and anti-inflammatory properties.

Quinoa

Quinoa is a part of amaranth family and related to spinach. The seeds are rich in dietary fiber, protein, B vitamins, and minerals in comparison to other cereal grains. It consists of trace nutrients such as flavonoids quercentin and kaempferol which have properties like anti –carcinogenic, anti-inflammatory in animal studies. It is high in fiber, provides bulk in diet and satiety.

Production of millets in India and Gujarat

According to Agriculture statistics 2019 report, overall production of millets in year 2018-2019 in India and Gujarat was 42.95 and 1.74 million tons respectively. The three major states producing millets are Rajasthan, Karnataka and Madhya Pradesh.

According to FAOSTAT of the United Nations (2016), global production of millet was 28.4 million tones, led by India with 36% of the world total.

An analysis done by Bhagirath das et al in 2019, on production of millets revealed that over the years the area for cultivation of pearl millet has decreased but the production of millet has increased, whereas the productivity of finger millet has increased but cultivation area and productivity has declined.

Consumption of millets in India and Gujarat

According to an analysis done by P. Anbukkani et al in 2017 on production and consumption of minor and finger millet it was found that the consumption of minor millets and finger millet was highest in 18.82kg/hsh/m in Assam and 18.69kg/hsh/m in Bihar.

A study by Mallavva Patil and Surekha Sankangoudar, 2019 it was found that none of the three groups of growers of same village, non growers of same village and non growers of different village consumed millets on daily basis but 87.23% of non growers of same village, 84% of growers of same village and 69.05% of non growers different village consumed minor millets occasionally.

The map shown below shows the overall millets grown in India:

Source: The Story of millets, 2018 (Sahaja Samrudha)

Nutrition composition of millets

Millets are highly nutritious cereals, which can be consumed by any age group individuals. They have many health beneficial functions which are helping aid against prevention of non -communicable diseases and many other diseases. They are alkaline in nature which helps in maintaining the pH balance and provides optimum nutrition to the body.

Grain	Carbohydrate (g)	Protein (g)	Fat (g)	Energy (Kcal)	Dietary fiber (g)	Ca (mg)	P (mg)	Fe (mg)
Sorghum	67.7	9.9	1.73	334	10.2	27.6	274	3.9
Pearl millet	61.8	10.9	5.43	347	11.5	27.4	289	6.4
Finger millet	66.8	7.2	1.92	320	11.2	364	210	4.6
Kodo millet	66.2	8.9	2.55	331	6.4	15.3	101	2.3
Proso millet*	70.4	12.5	1.10	341	-	14.0	206	0.8
Foxtail millet*	60.1	12.3	4.3	331	-	31.0	188	2.8
Little millet	65.5	10.1	3.89	346	7.7	16.1	130	1.2
Barnyard millet*	65.5	6.2	2.2	307	-	20.0	280	5.0
Amaranth seed	61	13.3	5.6	356	7.5	162	412	8.0
Quinoa	54	13.1	5.5	328	14.7	198	212	7.5

Source: Indian food composition tables, NIN- 2017;* Nutritive value of Indian Foods, NIN- 2007

Non-communicable diseases

Non communicable disease is a disease that is not transmitted from one person to another. They can be acute or chronic and are mostly heart related problems (cardiovascular disease), cancers, diabetes and chronic respiratory diseases. . These are chronic diseases of long duration, and generally slow progression and are the result of a combination of genetic, physiological, environmental and behavior factors. According to WHO the 5 important risk factors for NCDs are

- Raised blood pressure
- Raised cholesterol
- Tobacco use
- Alcohol consumption and
- Overweight

In India, nearly 5.8 million people (WHO report, 2015) die each year from non-communicable diseases (heart and lung disease, stroke, cancer and diabetes), or in other words, one in four Indian people is at risk of to die of a non-communicable disease before reaching old age 70. A report "India: Health of Nation-States" by the Ministry of Health and Family Welfare (MOHFW) of the Government of India (GOI) found that the contribution of non-communicable diseases was 30% of the total burden of the disease. Disability Adjusted Life Years (DALYs) in 1990 to 55% in 2016 and an increase in the proportion of NCD deaths (among all deaths) from 37% in 1990 to 61% in 2016.This shows a rapid epidemiological transition with a shift from the burden of disease to non-communicable diseases.

Millets and non communicable diseases

Diabetes

Millets are an excellent source of vitamins and minerals, have low glycemic index. The lower GI helps in slow digestion of carbohydrates in the body, which results in slow release of sugar in the blood stream and also the phenolic compounds in millets such as pancreatic amylase, alpha-glycosidase partially inhibit the enzymatic hydrolysis of complex carbohydrates, reducing the risk of postprandial hyperglycemia in individuals with diabetes type 2.

Cardiovascular diseases

Millets contain phyto-chemicals such as phtytic acid and tannins which aid in lowering cholesterol levels. They have good sources of magnesium, help in reducing the risk for heart attack. Millets also prevent LDL cholesterol oxidation as they are rich in soluble dietary fiber and antioxidants which helps in prevention of hypertension and other cardiovascular diseases.

Cancer

The effect of millets anti-carcinogenic properties are seen in vivo and vitro studies and show positive impact. Millets are rich in resistant starch which is converted by the intestinal bacteria in the gut into short chain fatty acids which helps protect against colon cancer and reduce the cancer causing factors activity till certain extent. The whole grain fiber also binds carcinogens and increases the fecal bulk.

Obesity

Millets are whole grains which are rich in dietary fiber and provide satiety which reduces the risk of over eating. Also they are a very good source of protein, minerals and vitamins and low in fat. The presence of tryptophan in millets which regulates appetite prevents excessive weight gain and overeating by the body.

In the view of the above, present study was planned with the following rationale:

- Millets have long been part of traditional Indian diets. The emergence of climate change and water scarcity as constraints in recent years has given the agricultural sector a rationale for investing in increasing millet production; the emergence of non-communicable diseases as a public health problem, and the realization that increased millet consumption may have benefits in reducing the incidence of cardiovascular diseases and diabetes have opened a window of opportunity to increase millet production and consumption.
- Millets are likely to offer protection against non-communicable diseases such as diabetes, cardiovascular diseases and cancer.

In view of the above, the present study was planned with the following broad objective:

To document the time trends in production of millets in Gujarat, its consumption pattern in urban Vadodara and development of recipes from millets to prevent NCDs.

In view of the above the present study was planned with the following specific objectives:

- To document the time trends of production of millets in India and Gujarat from the available secondary data source.
- To study the consumption pattern of millets in Gujarat from the available secondary data source.
- To assess the consumption pattern of millets among urban households of selected individuals with their consent in Vadodara.
- To develop 5 recipes each using selected major and minor millets for prevention of NCDs.

REVIEW OF LITERATURE

REVIEW OF LITERATURE

The change in the environmental conditions and increase in the awareness among the population regarding the benefits of millet consumption has given the agricultural sector a rationale for investing in increasing millet production. The present study's broad objective was planned:

To document the time trends in production of millets in Gujarat, its consumption pattern in urban Vadodara and development of recipes from millets to prevent NCDs.

The specific objectives of the present study were planned:

- To document the time trends of production of millets in India and Gujarat from the available secondary data source.
- To study the consumption pattern of millets in Gujarat from the available secondary data source.
- To assess the consumption pattern of millets among urban households of selected individuals with their consent in Vadodara.
- To develop 5 recipes each using selected major and minor millets for prevention of NCDs.

Review of literature has been presented under the following sub heads:

- Nutritive value and importance of millets
- Production and Consumption pattern of millets in India and Gujarat
- Non-communicable diseases (NCDs) and millets

Nutritive value and importance of millets

Millets are widely grown around the world and are important crops in semi-arid tropic region of Asia and Africa. They used as food grains and fodder for animals. They are a good source of energy, protein, vitamins and minerals for the poor people in these regions.

Sorghum

Sorghum as known as jowar, traditionally staple food of many states in India is nutritionally better than rice. Jowar is rich in protein, thiamine, riboflavin, folic acid, iron, β- carotene, calcium, phosphorous and dietary fiber. All these properties help in reducing heart problems, arthritis and obesity.

Pearl millet

Pearl millet or bajra is usually grown in Gujarat, Rajasthan and Haryana and can adapt to sandy-soils, low rainfall and low fertile soils. It consists of phyto- chemicals which lower cholesterol levels. It also contains minerals like magnesium, copper, zinc and iron.

Finger millet

Finger millet commonly known as ragi is grown in dry areas and extensively southern states of India. Finger millet grains are rich in essential and non essential amino acids like methionine, tryptophan and cystine. It contains 10-15% of dietary fiber, phyto-chemicals, calcium, phosphorous and other minerals. Ragi helps in prevention of chronic conditions like high blood cholesterol, high blood glucose levels and intestinal cancer.

Foxtail millet

Foxtail millet also known as Italian millet is recommended to diabetic patients as it helps in controlling of blood glucose levels and cholesterol levels. The grain structure of foxtail millet is quite similar to the grain of paddy rice. It is considered to be most digestible and non allergic after the outer husk is removed before consumption. It is also considered as a nutritive food for pregnant women and children as it contains proteins, calcium, vitamins, high dietary fiber and minerals such as copper and iron.

Kodo millet

Kodo millet is cultivated in India since 3000 years and is widely cultivated on gravelly or stony soil. Kodo millet is also known as kodari consists of 11% of protein, 4.2% of fat, and very high content 14.3% of dietary fiber. It is rich in Vitamin B9 (Folic acid),

Vitamin B3 (Niacin), Vitamin B6 (Pyridoxine) and minerals like iron, calcium, magnesium, potassium and zinc.

Proso millet

Proso millet is gluten free and has significant amounts of carbohydrates, fatty acids and proteins. It is also rich in dietary fiber and calcium which promotes healthy digestion and bone growth. It is comparatively low-demanding crop and well suited for many soil types and climate conditions.

Barnyard millet

Barnyard millet is grown well in different seasons in hilly regions of Uttrakhand in India. it is cultivated as food and fodder and is a good source of dietary fiber, proteins and some fatty acids. It is recommended to be consumed by patients with cardiovascular disease, celiac disease and diabetes.

Little millet

Little millet is known as one of the traditional crop of Karnataka and also grown throughout in India. It provides approximately 2% of calcium, 72% of iron and 31% of phosphorus of percentage daily value (%DV).

Amaranth

Amaranth is a pseudo cereal, grown throughout season and is consumed as a leafy vegetable also in southern parts of India. Cooked amaranth grain approximately provides 43% of manganese, 21% of phosphorous, 18% of magnesium, 16% of iron, 5% calcium and 3 % of potassium. It is also a good source of B complex Vitamins.

Buckwheat

Buckwheat is mostly cultivated in the hilly regions of India. It provides 20% or more of Daily value (DV) of protein, dietary fiber, four B vitamins and several dietary minerals with content specifically high that is 47 to 65% of DV in niacin, manganese, phosphorus and magnesium.

Quinoa

Quinoa is a pseudo cereal which is related to amaranth and spinach is cultivated in Kenya, India, the United States, several European countries and other 70 countries. Cooked quinoa provides 21% carbohydrates, 4% proteins, 2% fat and 72% of water of % DV. It provides 30% of manganese and 22% of phosphorus and moderate source of dietary fiber, folate and minerals like iron, zinc and magnesium approximately between 10-19 % of % DV.

According to **Himanshu et al 2018**, Millets are generally considered as food for the poorer in spite its high nutritional properties. Millets are comparatively high in energy, protein, fat, iron, calcium, zinc, dietary fiber than cereals and also are rich in phyto chemicals. These properties of millets have a preventive effect on chronic diseases such as cardiovascular disease, cancer and diabetes.

Sarita and Singh 2016 reported that millets are in keen interests of developing countries for increase its production as they can help in food security and need low maintenance compared to other crops. They are also promoted for their nutritive properties which aid in maintaining human health. The main concern of the study was to increase the promotion and production of millets and recognize them as an important and nutritious food to combat malnutrition and global population.

Kumar et al (2016) reported that bio-fortification of finger millet would be beneficial during nutritional crisis and for universal health.

Kumar et al (2018) millets are known as climate compliant crops and have high nutritional value. They are also known as nutri cereals which are rich in several dietary minerals and vitamins, phyto-chemicals, essential fatty acids and antioxidants which help in prevention and management of nutritional deficient diseases. Promotion of millet cultivation would ensure food security.

Hassan et al (2021) assessed that finger millet and pearl millet can be potentially used as an alternative source as feed for animals as they provide adequate amount of energy required in poultry diets. Also they are more than and equal to the nutrients which are

provided from cereals like maize, rice and wheat and the presence of nutraceuticals properties are beneficial for human health.

Krishnan and Meera (2018) reported that pearl millet has the potential to be used as a dietary component to tackle micronutrient deficiencies which would help in reducing the prevalence of malnutrition. As pearl millet is a rich in minerals like iron and zinc compared to other cereals and its bio accessibility can be improved with the help of different processing methods.

Boncompagni et al (2018) reported that the anti-nutrient compound phytate and goitrogenic compounds C- glycosylflavones (C-GFs) which are genetic components need to be dissected as they control seed nutritional phenotypes and characterization of their impact on grain nutritional value in pearl millet.

Kuamarva et al (2009) reported that sorghum staple food of majority of population in semi- arid tropics and is a gluten free coarse cereal. It consists of phenolic compound and antioxidant compounds which have many health benefits. Processing on the nutritional and visco-elastic properties of sorghum could help in promotion of sorghum in diets for human consumption.

Saleh et al (2013) the study concluded that millets contain dietary fiber, minerals, vitamins and phyto chemicals including phenolic compounds which have several health promoting and beneficial properties. To increase the bioavailability and micronutrient content of millets the preparation and processing methods should be enhanced.

Ramashia et al (2019) the study reported that finger millet has high concentration of carbohydrates, dietary fiber, phyto chemicals and essential amino acids and minerals, also is gluten free. Finger millets these nutritional properties aid in reducing the risk of diabetes mellitus, high blood pressure and gastro- intestinal tract disorders when consumed. Enhancing the traditional preparation and processing methods of finger millet also improve the utilization of its dietary and sensory properties and reduce the anti – nutrient properties present in the grains.

Anitha et al (2019) reported that millets based meal when replaced with the regular rice based mid- day meal showed significant improvement in stunting and body mass index (BMI). The sensory evaluation of the millet based recipes also showed high acceptability among children.

Amadou et al (2013) concluded that millets are staple food for lower income people of asia and Africa. They are energy dense, high in other dietary nutrition components, when millets combined with other sources of proteins they compensate and provide amino acids like lysine. The study also concludes that future consumption of millets would help in developing countries in its industrial revolution.

Gull et al (2014) in a study determined that finger millet which is known for its nutritional and functional properties such as nutritionally rich in calcium and dietary fiber and phenolic compounds. It also contains both essential and non essential amino acids such as isoleucine, leucine, methionine and phenyl alanine. The presence of these components provide health benefits such as anti- diabetic, anti –tumerogenic, atherosclerogenic effects and has antioxidant properties. As finger millet is indigenous crop and staple food in many different parts of India it is consumption needs to be promoted with the help of specifically designed foods.

Ugare et al (2011) in a study determined that dehulled and heat treated barnyard millet grains has shown positive impact on serum lipid and blood glucose levels in diabetic and non diabetic subjects with 28 days diet intervention study. Hence it was concluded that barnyard millet when dehulled and heat treated is beneficial for people with type 2 diabetes mellitus.

Singh and Raghuvanshi (2011) reported that millet and cereals are widely consumed in India and other developing countries. Finger millet is staple food of eastern and central part of India and Africa. It is considered to be easily digestible, least allergic and helps maintain health throughout seasons. Finger millet compared to rice is nutritionally rich in protein, fat and minerals like calcium and iron. It was concluded that awareness and promotion among the people about health benefits and nutrition value of finger millet should be done.

Singh et al (2019) reported that minor millets which are also known as nutria cereals small seeded cereals belong to Poaceae family are rich in nutrients such as calcium, magnesium, manganese, tryptophan, fiber, B vitamins and phosphorus, are essential for healthy maintenance of the human body. Minor millets can be cultivated in severe climatic conditions and require less water for cultivation.

Rao et al (2006) in a study reported that pearl millet and sorghum can be used as a solution to combat malnutrition due to micronutrient deficiency as they are rich sources of micronutrients such as insoluble dietary fiber, balanced amino acid profile, dietary minerals and B complex vitamins. They are low in cost and hence offer an opportunity for low- income households to improve their nutritional security.

Chandra et al (2016) reported that finger millet has higher nutritional content compared to other cereals such as barley, rye and oats. It is highly rich in calcium 0.34% and consists of other nutrients such as dietary fiber, phytates, protein, minerals and phenolic compounds. It is also rich in B complex vitamins and some essential amino acids. Presence of these properties in finger millet provide various health benefits such as anti-diabetic, anti- diarrheal, anti – ulcer, anti- inflammatory, anti –tumerogenic, anti microbial and antioxidant properties. (Table 2.1)

Table 2.1: Presents the nutritional composition of finger millet with other minor millets, pseudo millets and cereal grains.

		Protein (%)	Fat (%)	Starch (%)	Ash (%)	Crude fiber (%)	Total dietary fiber/100 g	Total phenol (mg/100 g)	Carbohydrates (g)
Minor millets	Finger millet	7.3	1.3	59.0	3	3.6	19.1	102	72.6
	Pearl millet	14.5	5.1	60.5	2	2	7	51.4	67.5
	Proso millet	11	3.5	56.1	3.6	9	8.5	0.10	70.4
	Foxtail millet	11.7	3.9	59.1	3	7	19.11	106	60.9
	Kodo millet	8.3	1.4	72.0	3.6	9	37.8	368	65.9
	Little millet	7.7	4.7	60.9	6.9	7.6	–	21.2	67
	Barnyard millet	6.2	4.8	60.3	4	13.6	13	26.7	65.5
Pseudo-cereals	Amarath	15.2	8	67.3	3.2	4.1	20.6	2.71	59.2
	Quinoa	13.3	7.5	69	2.6	3.8	14.2	2.8	69
	Buckwheat	10.9	2.7	67.2	1.59	10.1	29.5	7.25	66
Cereals	Wheat	14.4	2.3	64	1.8	2.9	12.1	20.5	71.2
	Rice	7.5	2.4	77.2	4.7	10.2	3.7	2.51	78.2
	Maize	12.1	4.6	62.3	1.8	2.3	12.8	2.91	66.2
	Sorghum	11	3.2	73.8	1.8	2.7	11.8	43.1	72.6
	Barley	11.5	2.2	58.5	2.9	5.6	15.4	16.4	80.7
	Oats	17.1	6.4	52.8	3.2	11.3	12.5	1.2	69.8
	Rye	13.4	1.8	68.3	2	2.1	16.1	13.2	80.1

Source: Chandra et al (2016)

According to **Gull et al (2015)** evaluated finger millet and pearl millet flour for chemical composition, nutritional, anti nutritional, pasting and micro structural properties. It was observed there was significant difference between the millet flours as protein; ash and fiber vary from 7.3 to 8.0g/100g, 2.73g to 5.16g/100g, and 3.03g to 3.05g/100g among the millet flours. The anti nutritional factors were 3.5mg/g and 2.2mg/g for tannic acid and 6.1mg/g and 9.2 mg/g for phytic acid whereas mineral availability was observed as (mg/100g) 109.2-139.2 for calcium, 0.73-4.2 for zinc, 1.18-8.70 for iron, 15.03-17.36 for sodium and 67.53-30.03 for potassium in pearl and finger millet flour respectively. It was also observed that finger millet showed high viscosity, breakdown, final and set back value compared to pearl millet flour.

Table 2.2: Presents the proximate composition and mineral analysis of finger and pearl millet flours.

Parameter	Finger millet flour	Pearl millet flour
Moisture (%)	12.06 ± 0.4^{a}	13.49 ± 0.17^{b}
Ash (%)	2.2 ± 0.12^{b}	0.73 ± 0.15^{a}
Fat (%)	2.73 ± 1.00^{a}	8.16 ± 0.20^{b}
Protein (%)	7.3 ± 0.12^{a}	8.00 ± 0.14^{b}
Fiber (%)	3.03 ± 0.05^{a}	3.05 ± 0.05^{b}
Carbohydrate (%)	68.00 ± 0.57^{b}	66.57 ± 0.4^{a}
Calcium (mg/100 g)	139.2 ± 1.0^{b}	109.2 ± 1.2^{a}
Zinc (mg/100 g)	0.73 ± 0.0^{a}	4.2 ± 0.8^{b}
Iron (mg/100 g)	1.18 ± 0.2^{a}	8.7 ± 1.5^{b}
Sodium (mg/100 g)	15.03 ± 1.0^{a}	17.36 ± 1.7^{b}
Potassium (mg/100 g)	67.53 ± 1.9^{a}	30.03 ± 2.0^{b}
Tannin acid (mg/g)	3.5 ± 0.6^{a}	2.2 ± 0.6^{b}
Phytic acid (mg/g)	6.1 ± 0.7^{a}	9.2 ± 1.0^{b}

Source: Gull et al (2015)

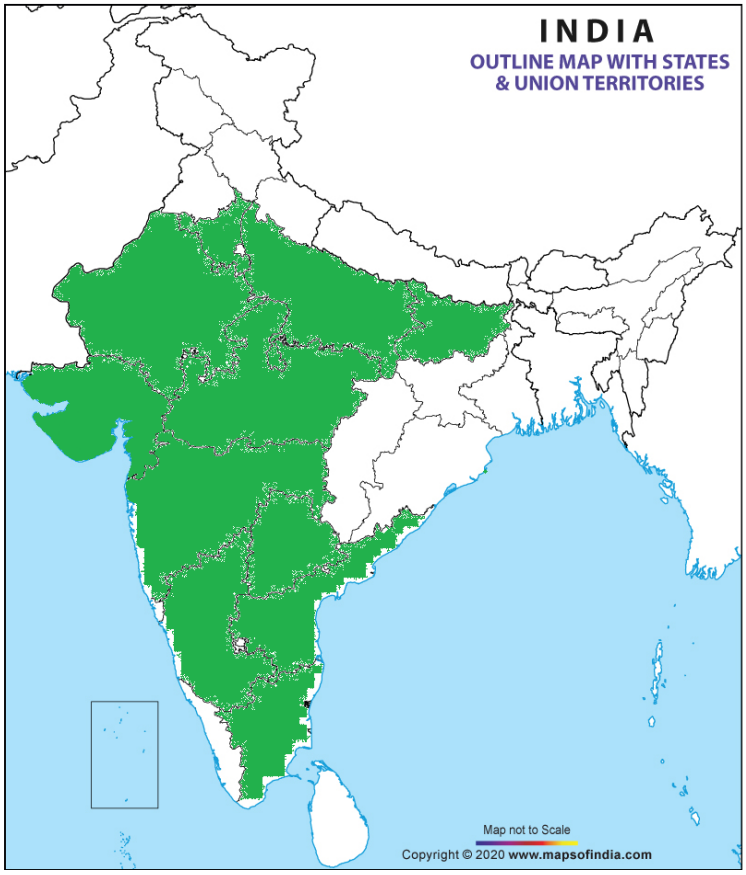
Datir et al (2018) pearl millet is an important crop which provides minerals which are required for maintenance of human body. In children especially malnutrition is a greater concern as it affects the growth, cognitive development and resistance to infection in the child. In India malnutrition due to mineral deficiency is a problem as children are suffering mineral deficiency due to insufficient mineral rich diet. To their aid pearl millet which is rich in iron, zinc and other minerals can be provided for balancing the mineral requirements in their diets. Varieties of pearl millet which are rich in iron and zinc can be developed and provided to meet mineral deficiency needs of the needy.

According to **Bhat et al (2017)** small millets (kodo millet, foxtail millet, barnyard millet, little millet and proso millet) are considered as nutri-cereals are source of food, fodder and feed. They provide major nutrients such as protein, carbohydrates, fats but also provide good amount of fiber, minerals and vitamins. The study emphasized on nutraceutical properties of small millets and it was observed as they have the potential to be extensive therapeutic food which provides high energy and high protein with fiber rich diet. The study also concludes that minor millets are good source of phenolic acids and glycated flavonoids which can be used as food medicine and have the potential to enhance viability of probiotics.

Production and consumption pattern of millets

Millets such as jowar, bajra, ragi and others require temperature in between 27-32 degree Celsius and rainfall around 50-100cm for cultivation. Millets can be grown in inferior alluvial or loamy soil because they are less sensitive to soil deficiencies. Jowar is a rain-fed crop grows in moist areas with less or no irrigation whereas bajra can grow in sandy soils and shallow black soil. Ragi grows in dry regions in soils such as red, black, sandy, loamy and shallow black soils. Throughout India the top millet producing states are Rajasthan, Karnataka, Maharashtra, Madhya Pradesh and Uttar Pradesh. The government of India has launched some schemes such as National Agricultural Insurance Scheme and Initiative for Nutritional Security through Intensive Millets Promotion to support millet production. The map in figure shows the major states which produce millets in India.

Figure 2.1: Map of India showing major states producing millets.



Source: iasshika

According to a study done in **2012 by Reddy et al**, it focused on the demand and supply for pearl millet and fodder was estimated that the demand and supply of pearl millet for cattle feed will increase by 38.6% and for poultry feed it will increase by 9.4%, whereas for alcohol and other non food industry it will increase by 11.7%.40 % decrease in the demand and supply of pearl millet for food uses will be seen in year 2020.

Michelraj and Shanmugam (2013) reported that with new technology the yield of millets has increased to 82% in finger millet, 95% in little millet, 83% in kodo millet, 43% in foxtail millet, 76% in proso millet and 82% in barnyard millet. Small millets are cultivated for socio economic benefits to the farmers as they assure income and have low agricultural maintenance. As millets are nutrient dense and help in prevention of many

diseases, it is important and needed to increase the awareness about millet consumption on daily meals for healthy living and combat with the current lifestyle modifications.

Ankukkani et al (2017) reported that production of small millets was highest in Uttar Pradesh, Tamil Nadu and Gujarat. The consumption of small millets was found highest in Assam and Bihar whereas consumption of finger millets was highest in Bihar and Karnataka in all India and rural areas by using NSSO unit level data. The study also concluded that the area under production of minor and finger millet has decreased drastically from 1955-56 to 2013-2014 (Table 2.3)

Table 2.3: Area, production and yield of small millets and finger millet from 1950-2014.

	1955-56	1965-66	1975-76	1985-86	1995-96	2005-06	2013-14
			Small millets				
Area (Lakh ha)	53.35	45.64	46.72	31.55	16.62	10.64	6.82
Production (Lakh tones)	20.7	15.55	19.24	12.17	7.79	4.72	4.29
Yield (q/ ha)	388	341	412	386	469	443	633
			Finger millet				
Area (Lakh ha)	23.07	26.96	26.3	24.01	17.74	15.34	11.93
Production (Lakh tones)	18.46	13.27	27.97	25.18	25.01	23.54	19.92
Yield (kg/ ha)	800	492	1064	1049	1410	1534	1661

Source: Ankukkani et al, 2017

Raju et al (2018) reported that the consumption of finger millet (ragi) was 27% and 17 % among the urban and rural population of south Karnataka whereas Sorghum (jowar) was largely consumed in North Karnataka with 34% and 13% of rural and urban population respectively. It also reported that Karnataka state in 2014 had started implementing millets through PDS (public distributing system) under the act National Food Security Act (NFSA, 2013) as rice and wheat were not nutritionally adequate to meet the requirements of individuals.

Basavaraj et al (2010) concluded that despite of overall decline in pearl millet consumption in India (2000 to 2004), consumption of pearl millet was consumed by urban and rural poor people and some high income groups. Other that food consumption

of pearl millet other industries demand for pearl millet has increased leading to increase in production from 5% to 55% in 2004-2005.

Patil and Sankangoudar (2019) concluded that the consumption of minor millets among the growers and non growers of minor millets in Karnataka was not consumed on daily basis in spite being aware about the benefits millets have in prevention of diabetes, obesity and other diseases. Among the selected 180 subjects it was observed that majority of farmers cultivated foxtail and little mille in restricted areas and about 84% of growers and 87.23% of non growers of same village and 69.05% of non growers of different village consumed millets occasionally.

Selvi and Malthi (2019) reported that consumption of millets was found to be 30% finger millet, 28% sorghum, 17% kodo millet, 16.7% barnyard millet and 8.3% pearl millet was observed in among 120 rural women subjects selected from Mangalrevu village in Peraiyur taluka, Madurai district of Tamil Nadu.

Kalaiselvi and Fathima (2016) in a study concluded that millets are nutritious crops which provide numerous securities such as food, fodder, nutrition, livelihood, health and economy to the poor people. Longer consumption of millets would provide health benefits to individuals and it would also help in resisting malnutrition.

Gowri and Shivkumar (2020) reported that the scenario of millets in India from 1950-51 to 2018-19 was analyzed using compound growth rate, was observed as the area and production is declining at the rate of 16.31% and 13.58 yearly respectively. It was also observed in the same way that productivity was declining till 2005, after which 3.23% of positive growth was seen. The data was collected from ministry of economics and statistics, seasonal and crop report. Hence the study concludes that providing proper cultivation practice, marketing and processing of millets will improve the millet production in India. (Table 2.4)

Table 2.4: Trend in area, production and yield of millets in India (1950-51 to 2018-19)

Year	Area ('000 ha)	Production ('000 tn)	Productivity (Kg/ha)
1950-51 to 1954-55	5144	2113	409
1955-56 to 1959-60	5098	1987	389
1960-61 to 1964-65	4755	1960	413
1960-61 to 1969-70	4697	1697	361
1970-71 to 1974-75	4512	1758	389
1975-76 to 1979-80	4465	1813	405
1980-81 to 1984-85	3623	1462	403
1985-86 to 1989-90	2895	1204	417
1990-91 to 1994-95	2040	931	456
1995-96 to 1999-2000	1540	688	447
2001-05 to 2004-05	1246	533	428
2005-06 to 2009-10	970	466	480
2011-12 to 2014-15	725	429	596
2015-16 to 2018-19	623	401	655
CGR	-16.21	-13.58	3.23

Source: Goawri and Shivkumar, 2020

Jaisridhar et al (2020) in a study measured the attitude of millet farmers and their orientation towards changing trends in millet cultivation which was conducted in Vellore and Triuvannamalai. It was observed that out of 120 participants the 85% and 80% of respondents agreed that millets had supportive role in marginal life of farmers and 55% and 70% of respondents agreed that they had lack of awareness on environmental sustainability and nutritional in millets in Triuvannamalai and Vellore districts respectively.

Michaelraj and Shanmugam (2013) in a study conducted in Karur district of Tamil Nadu suggested that to improve the millet production a developmental effort should be made through state level training programs and mini kit demonstrations as these would help in increasing the yielding capacity of millets by replacing the old local varieties with newly released varieties. A systematic follow up and subsidization of new variety of seeds should be considered and provided by the government for promotion of increase production of millets.

King and MSSRF (2016) concluded that millet cultivation is neglected in spite of hard working women labor due to lack of processing machines for millets, less labor and low

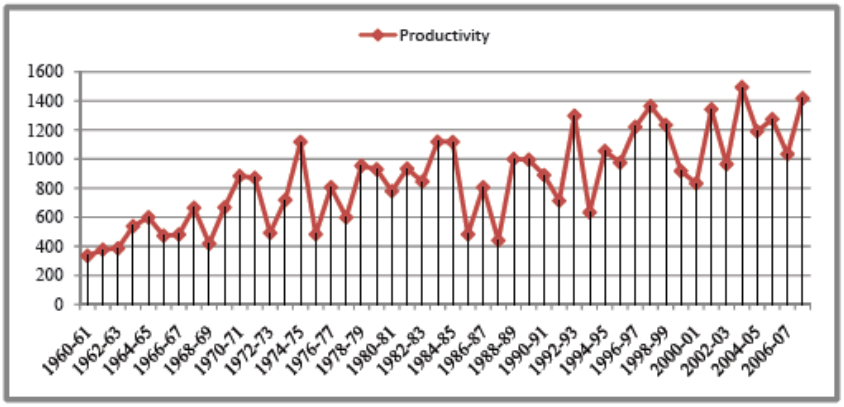
profit ability of millets. Hence to maintain millet production in Kolli Hills, development and evolving of cropping systems and machinery was considered and post intervention with the help of research foundation the production of millets is at little ease for the women laborers.

Mondal et al (2016) reported that in Madhya Pradesh minor millets are traditional to rain fed farming system are declining due to livelihoods of Gond and Baiga farmers is shifted to wage workers. To promote millet commercialization three companies were established in 2013, to provide high quality seeds and grains, store fronts, warehouse facilities and other infrastructure. Also to increase awareness among the people a millet gala was organized and was declared via radio for participation of locals and millet recipes and packets were provided and made for tasting and promotion.

Gowri and Prabu (2018) reported that the area under millet production is declining from 41 Mha in 1980-85 to 26 Mha in 2010-13, that is decline in area about 1.50% per annum. To conclude except for barnyard millet all other millets have suffered a decline up to 6 to 10% and 4 to 8% every year in area and yield every year in Tamil Nadu.

Kour et al (2017) concluded that the area under production of pearl millet in Gujarat over the years has been decreasing and increasing in positive and negative manner respectively. The reason for concern is that the area had been decreasing rapidly whereas the productivity has increased, hence overall production has decreased. (Figure2.1)

Figure2.1: Graphical representation of pearl millet productivity data



Source: Kour et al (2017)

According to **DeFries et al (2018)** reported that coarse cereal(jowar, bajra, maize and ragi) reduced from 23% to 6% of calories from cereals in rural households whereas 10% to 3% of calories from cereals in urban households, 1983 to 2011 in India respectively. As coarse cereals are high in iron content, the decline in coarse cereal consumption has led to overall decrease in iron intake cereals. Hence it was indicated that loss of coarse cereal in Indian diet has significantly reduced iron intake without compensation from other food groups.

Non –communicable diseases (NCDs)

Non- communicable diseases are also know as chronic diseases which are non infectious and cannot be spread from person to person. The factors which cause NCDs are a combination of genetic, physiological, lifestyle and environmental factors. Cardiovascular diseases, cancer, chronic respiratory diseases and diabetes are the four main types of NCDs.

All the age groups, regions and countries people are at the risk to be affected by NCDs. These are more commonly associated with people of older age groups. However, 15 million annual deaths occur among the age group of 39 to 69 years. More than 85% of these deaths occur in low and middle income countries and vulnerable communities where the healthcare system is undeveloped.

The risk factors which increase the risk of NCDs are:

- Modifiable behavioral risk factors are tobacco use, physical inactivity, unhealthy diet and harmful use of alcohol.
- Metabolic risk factors are the four key metabolic changes such as raised blood pressure, overweight/ obesity, hyperglycemia (high blood glucose levels) and hyperlipidemia (high levels of fat in the body).

Cardiovascular diseases

Cardiovascular diseases (CVDs) are a group of disorder of heart and blood vessels which include heart attack, stroke, coronary artery disease, cerebrovascular disease, peripheral artery disease, congenital heart disease, deep vein thrombosis and pulmonary embolism.

CVDs are the leading causes of non-communicable disease death but can be predicted early and treatable.

Prevalence

The prevalence of CVDs is 47% in developing countries whereas 27% in develop countries below 70 years. In India onset of CVD is at an early age, it is more severe and the progression is rapid and aggressive.

Risk factors

The risk factors for cardiovascular disease are classified into four categories:

Category I: Risk factors for which interventions have been proven to lower CVD risk.

- Cigarette smoking
- LDL cholesterol
- High fat/cholesterol
- Hypertension
- Left ventricular hypertrophy
- Thrombogenic factors

Category II: Risk factors for which interventions are likely to lower CVD risk.

- Diabetes mellitus
- Physical inactivity
- HDL cholesterol
- Triglycerides, small dense LDL
- Obesity
- Postmenopausal status

Category III: Risk factors associated with increased CVD risk that if modified, might lower risk.

- Psychological factors
- Lipoprotein (a)
- Homocysteine
- Oxidative stress
- No alcohol consumption

Category IV: Risk factors associated with increased CVD risk which cannot be modified.

- Age
- Male gender
- Family history of early onset CVD

Medical nutrition therapy (MNT)

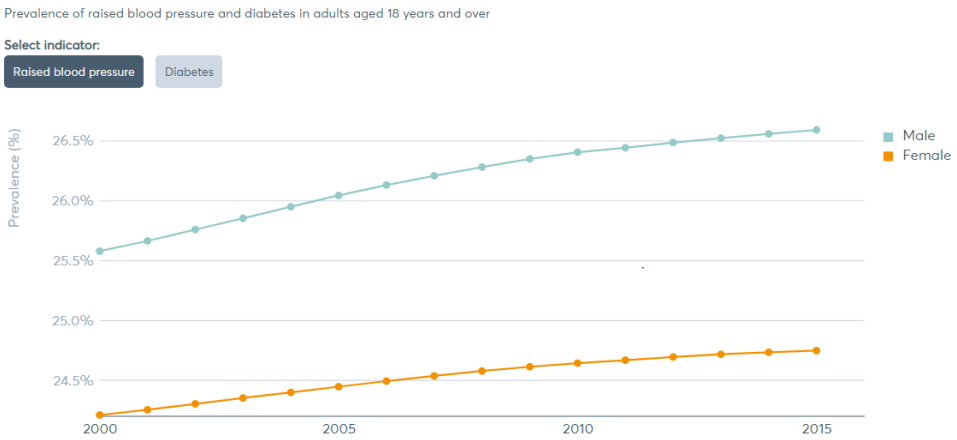
Diet therapy remains the first line of treatment for patients with high blood cholesterol levels. Low calorie, low fat particularly low saturated fat, low cholesterol, high in PUFA with ω-6 to ω-3 ratio 4-10:1, low carbohydrate and normal protein, minerals and vitamins are suggested. High fiber diet with increased amount of antioxidants is also recommended.

Dietary guidelines

- Amount of total calories should be restricted. Calorie intake and physical activity should be balanced to maintain a healthy body weight.
- Consumption of variety of foods which are low in fat, saturated fat and cholesterol. Trans fat should be avoided. Intake of bakery products should be limited.
- Vegetable oils rich in poly unsaturated fatty acids like safflower and sunflower oil should be included, solid fats should be avoided. Olive oil can included as rich in monounsaturated fatty acid.
- Eggs should be restricted and animal foods like meat and pork should be avoided as contain high amount of saturated fatty acids. Chicken can consumed instead of red meats, consumption of sea foods should be avoided as rich in sodium.
- Five servings of fruit and vegetables should be included in the diet not only to meet the nutritional requirement but also to meet antioxidants and fiber.
- Foods giving empty calories should be avoided such as carbohydrate beverages, alcohol sugar and sago should be avoided.

Along with dietary and life modifications, exercise and proper medication can reduce the risk of atherosclerosis through one cannot substitute the other.

Figure 2.2: Prevalence of raised blood pressure in India 2020



Source: Global Nutrition report, 2020

Cancer

The second most common cause of non communicable deaths, it affects people of all ages, gender, socioeconomic status and ethnicities. Avoiding tobacco and limiting alcohol consumption and also getting immunized against the cancer causing infection can help in prevention from cancer. The most common cancer deaths which occur in men and women due to cancer worldwide are lung, liver, prostate, stomach, cervical, colorectal and breast. In 2015, 1 of 6 deaths, globally were caused by cancer.

In Indian scenario approximately 7, 00,000 individuals develop cancer every year and annual mortality is about 4, 00,000.

Risk factors

Different cancers have different risk factors but two components are invariably involved in the etiology of cancers which are genetic and environment factors.

Heredity: Certain families have strong heredity tendency to cancer, as they are predisposed to cancer the genes are already mutated as cancer require two or more than mutations to occur, they inherited the genome. The most familiar cancers are breast, ovarian and colon cancers.

Environmental factors are

- Ionizing radiation
- Chemical substances
- Dietary factors
- Estrogens
- Viruses
- Stress
- Age
- Physical activity
- Immune factors

Medical nutritional therapy and dietary guidelines

Normal ingestion of food and nutrient supplements is most desirable. It is generally based on individual nutritional assessment and a number of adjustments in food texture, temperature, amount, timing, taste, appearance and form can be made to alleviate symptoms. A positive mental attitude with the help of family members towards diet should be integral part of the treatment.

Chronic respiratory disease

Chronic respiratory diseases generally affect the airways and the lungs and can be genetic also. They are incurable diseases but can be managed with medical treatments. They are chronic obstructive pulmonary disease (COPD), asthma, occupational lung disease and pulmonary hypertension.

Prevalence

The prevalence of chronic respiratory diseases was 20.0% asthma and 75.6% COPD in India (2016). The number of cases of COPD in India increased from 28.1 million in 1990 to 55.3 million in 2016 that is 3.3% to 4.2% increase in prevalence was observed.

Risk factors

- Air pollution
- Tobacco use
- Occupational risks

Medical nutritional therapy (MNT)

The goals for MNT are to restore the lean body mass, to achieve and maintain near normal body weight, avoid irritants in diet and meet the nutritional deficiencies. In severe cases avoid aggressive nutrition therapy, minimize muscle catabolism and prevent the progression of the disease to severe.

Diabetes

Diabetes is a condition when the body cannot produce enough insulin to regulate the blood sugar levels and its effects include heart disease, vision loss and kidney injury. There are 2 types of diabetes:

- Type 1 diabetes: it is diagnosed during childhood or young adulthood and is result of immune system dysfunction.
- Type 2 diabetes: often acquired during later adulthood because of poor diet, inactivity, obesity and other lifestyle and environmental factors.

Prevalence

A study by ICMR showed that prevalence of 2.5% in urban and 1.8% in rural population above age of 15 years was observed in India. The prevalence is 2.8% among those who are still engaged in strenuous physical activity compared to 48.3% living a sedentary life style. One in every eight individuals in India is a diabetic. According to revised WHO figures for the year 2025 is 57.2 million diabetics in India and the average age for onset of diabetes in India is around 40 years whereas in 55 years in other countries.

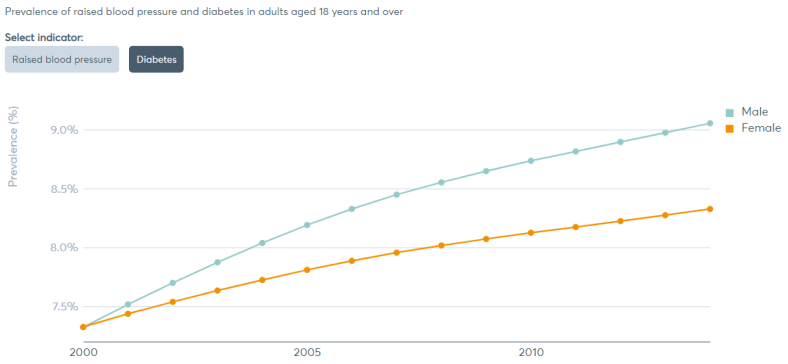
Medical nutrition therapy (MNT)

- Complex carbohydrates and fiber should be included in the diet. 20-40g of dietary fiber can be included per 1000 kcal consumed.
- High protein intake helps to increase insulin production and promotes satiety.
- Vitamins and minerals are supplemented if needed especially fat soluble vitamins.

- Individuals should avoid fasting and feasting. Regulating of meals is needed for person taking insulin. Meals should be spaced to consider with availability of insulin.
- Sodium intake is to be no more than 6g daily. Sodium restricted to 3g in hypertensive diabetic patients.
- The diet should meet the requirements of antioxidants, micronutrients and phytochemicals, the intake of permitted vegetables and fruits should be increased.
- Increased intake of whole grains and legumes and reduced intake of fat specially the saturated fat also improves insulin sensitivity and reduce the risk of diabetes independent of weight loss.

According to WHO report, 2015 India nearly reported 5.8 million people died from NCDs such as heart and lung diseases, stroke, cancer and diabetes. Almost every year 1 in 4 Indians have a risk of dying from an NCD before they age 70.

Figure 2.3: Prevalence of diabetes in India 2020



Source: Global Nutrition report, 2020

Non communicable diseases and millets

Jali et al (2012) the crossover study in which subjects with type 2 diabetes were provided with a millet based diabetic diet for 90 days showed that it had lowered the HbA1c , fasting glucose and density lipoprotein cholesterol. Hence to conclude patients with type 2 diabetes when include millet based dietary fiber in their diet it improves the glycemic control, decreases hyperinsulinemia and lowers the plasma lipid concentrations.

Yadav et al (2013) in a study concluded that products which incorporate kodo millet have better glucose control compared to other cereals and will help in avoiding complications related to diabetes.

Nambiar et al (2011) reported that pearl millet, major staple food for the Indian population consists of nutritional and nutraceutical properties which potentially aid in prevention of diabetes, constipation, celiac diseases and other non- communicable diseases. (Figure 2.4)

Figure 2.4: Possible health benefits of pearl millet on various diet related disease/ disorders and deficiency

DISEASE/PROBLEM	POSSIBLE BENEFIT	POSITIVE FACTOR IN PEARL MILLET
Anemia	May Help in increasing the Hb	High iron content (8mg/100g) High Zinc content (3.1mg/100g)
Constipation	May help in dealing with constipation	High fiber (1.2g/100g)
Cancer	Anti cancer property Inhibit tumor development	Antioxidant property, high flavonoids
Diabetes	Help in dealing with diabetes	Has Low glycemic index
Celiac	Anti allergic	Gluten free
Diarrhea	Probiotic treatment	Lactic acid bacteria
NCDs	Inhibits DNA scission, LDL cholesterol, liposome oxidation and proliferation of HT-29 adenocarcinoma cells.	Flavonoids, phenolics, Omega 3 fatty acids

Source: Nambiar et al, 2011

Rao et al (2019) concluded that out of 142 participants, 69 participants which consumed millet based diet had shown significant lower body mass index, systolic BP, fasting blood sugar levels, post prandial blood sugar levels, total serum cholesterol levels, serum LDL levels, serum triglyceride levels and significant high levels of HDL compared to the non-millet consuming group of participants. Hence potential benefits of millet consumption can aid in managing the growing metabolic syndrome.

Kam et al (2016) reported that life style and dietary modifications may aid in curbing the curve of prevalence of diabetes which is increasing. Among the dietary modifications consumption of millets will be beneficial to the individuals as they consist of nutritional properties which would help in managing diabetes.

Taylor et al (2014) In a study concluded that millets have phyto chemicals which have potential health benefits such as reducing or preventing oxidative stress, anti- cancer, anti- diabetic, anti- inflammatory and cardiovascular disease prevention and anti hypertensive.

Nambiar and Patwardhan (2014) in a study concluded that out total 111 subjects, 69 % and 31% of the subjects had diabetes and diabetes and hyperlipidemia both respectively. It was found that prevalence of diseases condition was 66% in sedentary workers and the subjects had poor knowledge about the various millets except bajra and jowar and their roles for medical nutrition therapy for diabetes and their glycemic index. The consumption of millet was found to be independent irrespective of millet production area or availability of millets. Hence to conclude the diabetic subjects in spite of being aware about the health benefits of millets were not able to follow the routine usage of millets.

According to **Ambati and Sucharith (2019)** concluded that millets need to be promoted at global level as they can aid in prevention of global issue of malnutrition. They consist of phytochemicals which promote potential health benefits which help in prevention of metabolic disorders such as diabetes, obesity, cardiovascular disease. They are rich in good protein content which promotes growth and development and good calcium content promotes bone development in all the age groups. They are rich in iron and gluten free which aid in anemic and celiac disease patients respectively. Millets consist of phytosterols and policosanols which is present in the waxy layers of millet are cardio protective.

Hou et al (2018) replaced staple food of untreated mild hypertensive subjects with whole foxtail millet for 12 weeks time period in the study for clinical intervention. The results were significant reductions in their systolic and diastolic blood pressure was observed and the body mass index, body fat percentage and fat mass had significantly decreased. It was also observed that intake of foxtail millet had improved the fasting blood glucose levels in the subjects. Hence whole foxtail millet intake may potentially ease cardiovascular diseases and improve hypertension in individuals as it serves as potential source of functional and nutraceutical food.

Shahidi and Chandrashekara (2013) concluded that millets are widely cultivated and consumed in countries of Asia and Africa. Millets serve as potential source of macro and micronutrients like other cereals and are also rich in phyto chemicals and phenols which help in prevention of disease such as hypertension, diabetes type II and cardiovascular diseases. Hence there is a significance effect of millet on reduction of NCDs and improving health.

Fardet et al (2008) reported that there is sturdy medical specialty proof that whole-grain cereals defend the body against age-related diseases like diabetes, cardiovascular diseases and a few cancers. This may be due to presence of fiber and micronutrients within the outer layer and germ fractions of the grain acting along to combat oxidative stress, inflammation, hyperglycemia and carcinogenesis. Oxidative stress is related to these metabolic diseases. Whole-grain cereals are a good source of Vitamin E, folates, phenolic resin acids, zinc, iron, selenium, copper, manganese, carotenoids, phytic acid, lignins, lignans, and alkylresorcinols, all of that have vital inhibitor potential in vitro. Phenolic resin acids such as ferulic acid are characteristic of cereals. They will scavenge free-radical chemical element species each in vitro and in vivo. Phenolics might also act in vivo by triggering factor induction/repression via cell signaling through transcription factors. Whole-grain cereals also are an honest supply of betaine, vitamin B and sulphur amino acids which will improve inhibitor status.

Devi et al (2014) in a review concluded that finger millet which is one of the major millets, staple food in India for lower income groups is nutritionally important as has severe health benefits as consists of polyphenol and dietary fiber. It contains high amounts of calcium, dietary fiber and phenolic compounds which have health beneficial effects such as anti- diabetic, anti – tumerogenic, atherosclerogenic effects, antioxidant and antimicrobial properties.

According to **Chitra and Sulaiman (2017)** minor millets are nutritionally beneficial to human body and long term consumption of minor millets may bring health benefits to the people. They are rich in magnesium and are gluten free which helps in reducing the risk of migraine attacks, atherosclerosis and diabetic heart diseases.

Singh et al (2020) conducted a millet based functional food rich diet intervention on 60 subjects with type II diabetes mellitus it was found that after 12 weeks, significant decline in fasting and 2- hour postprandial blood glucose levels was observed. Also decline in other parameters like HbA1c, oxidative stress, blood pressure, blood lipoproteins and pro- inflammatory cytokines were declined. An increase in antioxidants vitamins, magnesium, calcium and hemoglobin was also observed after millet based intervention diet (60% millets, 20% soya bean, 10% brown rice, 8% peanuts and 2% flax seeds).

METHODS AND MATERIALS

METHODOLOGY

India is known as the largest producer of millets in the world. The government of India declared the year 2018 as the year of millets and launched a campaign to promote millets across India on September 28, 2018. This mission comes under the NATIONAL FOOD SECURTY MISSION (NFSM), launched in year 2007. Before this mission millets were promoted under INSIMP (Nutrition Security through Intensive Millets Promotion) during 2011-12 to 2013-14. In today's scenario millets are promoted through technology, dissemination, seed quality through millet seed hubs. Awareness generation, minimum support price and inclusion in PDS. Millets are considered to be a part of Indian culture and traditional diets. The change in the environmental conditions and increase in the awareness among the population regarding the benefits of millet consumption has given the agricultural sector a rationale for investing in increasing millet production.

Broad objective of the study:

To document the time trends in production of millets in Gujarat, its consumption pattern in urban Vadodara and development of recipes from millets to prevent NCDs.
The specific objectives of the study are

- To document the time trends of production of millets in India and Gujarat from the available secondary data source.
- To study the consumption pattern of millets in Gujarat from the available secondary data source.
- To assess the consumption pattern of millets among urban households of selected individuals with their consent in Vadodara.
- To develop 5 recipes each using selected major and minor millets for prevention of NCDs.

The study was approved by the institutional ethical committee wide community number: IECHR/FCSC/2020/48.

The study was carried out in three phases:

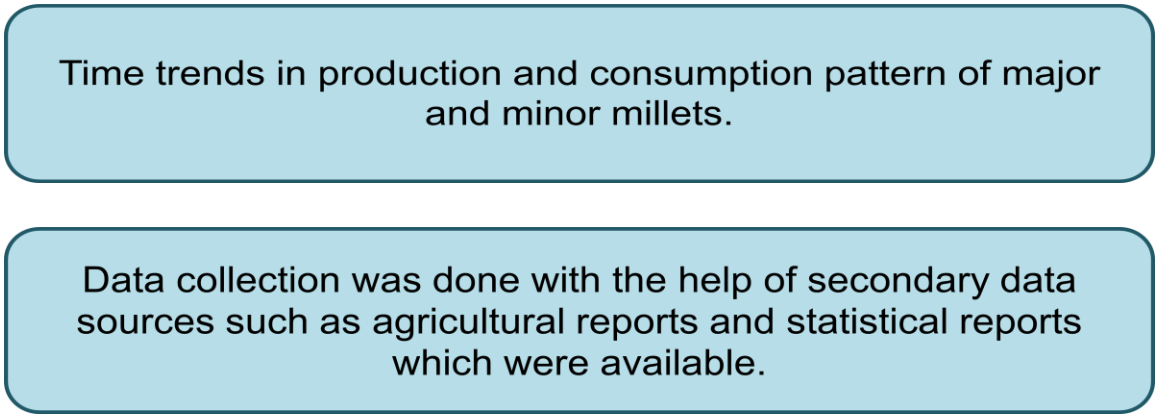
Phase 1: Documentation of time trends in production and consumption pattern of major and minor millets.

Phase 2: Consumption pattern of millets among urban population of Vadodara.

Phase 3: Recipe development from selected major and minor millets for prevention of NCDs.

The detailed experimental design is presented in figure 3.1

Figure 3.1: Experimental design for phase 1



Phase 1: Documentation of time trends in production and consumption pattern of major and minor millets.

The time trends in production and consumption of major and minor millets data was analyzed using available statistical reports from department of agricultural reports, NNMB reports and several research articles. The reports/ articles reviewed were:

1. Agricultural statistics at a glance,2019
2. 4th Advance Estimate 2019-20
3. AERC Report 2012
4. FAO reports
5. State of Gujarat agricultural report 2011-12
6. NNMB (2002 to 2017)
7. Millets future of food and farming (FIAN, India 2015)
8. Supporting millets in India (policy review & suggestions for actions, 2012)

9. Millet support policies, 2012
10. Research articles

Phase 2: Consumption pattern of millets among urban population of Vadodara.

To determine the consumption pattern of millets among the households which are present in urban Vadodara. The sample size was determined using random sampling. Vadodara is divided into 4 zones i.e. East, West, North and South and under each zones there 3 wards each. From the each zone one society was selected randomly and with personal interview with respondents data was obtained.

Sample size calculation

The sample size was calculated as per the national sample survey organization (NSSO) 2011, the percentage (%) of households consuming any millet is 90% to 95%. Based on that using EPI info formula, sample size was coming to 86.4 rounding off to 100. Hence sample size to be surveyed was 100 and 25 households from each zone were enrolled in the study.

Population size: 200000

Confidence level (%) 5%

Frequency anticipated 94%

Design effect 1.0

Formula used: $(1.96)^2(0.94)(1\text{-}0.94)(0.05)^2$

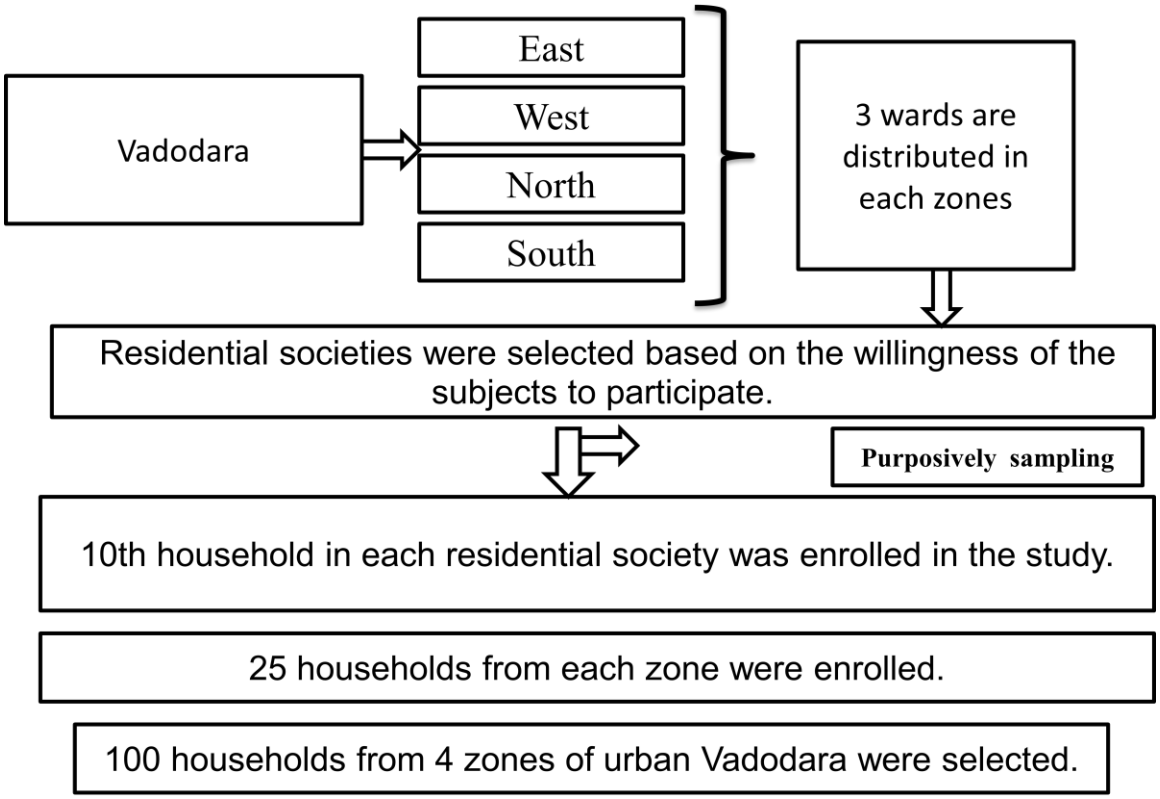
Sample size required: 100 households

Selection of the households

To get the representable sample from Vadodara city, the sample was drawn using multi-stage sampling. At the first stage cluster sampling was employed. For this, the list of all 12 wards of the city was obtained as per zonal distribution from the Vadodara Mahanagar Seva Sadan (VMSS). Each zone has three wards and from each zone residential socities were purposively selected based on the willingness of the participants, every 10^{th} household from each residential society was enrolled in the study. In all, 25 households from selected residential socities were enrolled, giving total of 100 households as shown below.

Criteria for selection of households

The households who gave the consent for the study



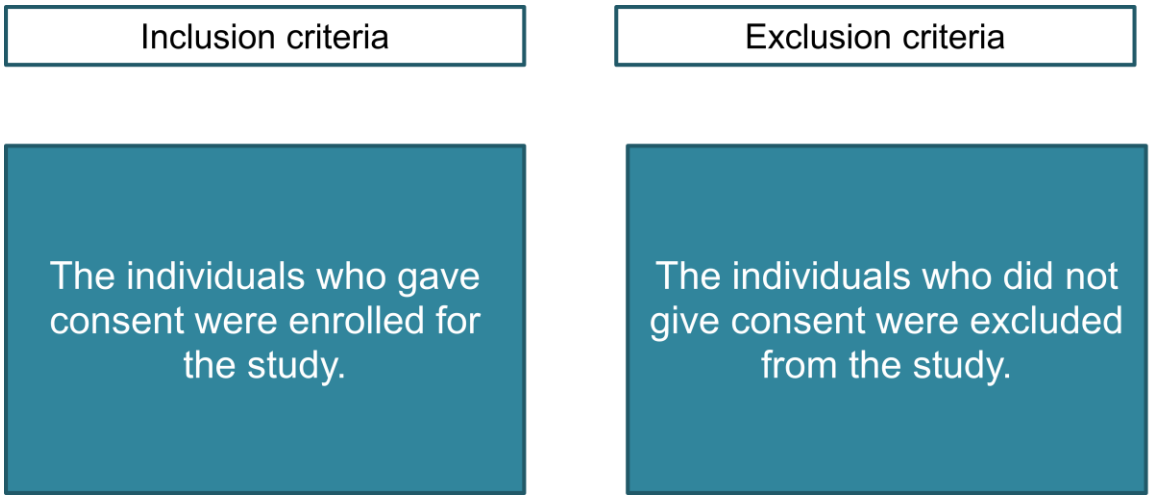
Data collection

The consumption pattern of millets was determined among the urban households of Vadodara using a structured pre tested questionnaire, information on level of education, occupation, religion, family type, socio-economic status, ethnicity and medical history was obtained through personal interview. The consumption pattern and frequency of millets consumed in the household was also obtained. The type of diet consumed, number of meals consumed and the intake of food in grams per day throughout the day was obtained through 24 hour dietary recall, to determine the household dietary diversity score. (Appendix 1)

The table shows tools and techniques used for data collection.

Parameters	**Tools**
Background information	Pre-tested semi structured questionnaire
Socio-economic status	Pre-tested semi structured questionnaire
Medical history	Pre-tested semi structured questionnaire
Knowledge and awareness about millet consumption	Pre-tested semi structured questionnaire
Frequency of consumption of millets	Pre-tested semi structured questionnaire and food frequency questionnaire
Dietary profile and meals consumed	Pre-tested semi structured questionnaire and 24 hour dietary recall

Inclusion and exclusion criteria for phase 2.



Phase 3: Recipe development from selected major and minor millets for prevention of NCDs.

The development of recipes using selected major and minor millets for prevention of non-communicable diseases (NCDs) was done considering the guidelines provided for prevention of NCDs. A recipe booklet consisting of 30 recipes was developed.

The major and minor millets which were selected for recipe development were based on the availability and its consumption in the city. The groups of selected millets are Pearl millet, Sorghum, Finger millet, Kodo millet, Barnyard millet and Amaranth.

Recipe book contains the following information:

- Raw and cooked weight and volume of recipe
- Nutritive value of one serving (energy, protein, fat, calcium, iron and fiber)
- Cost per serving
- Cooking method
- Benefits of consuming

Standardization of recipes

All the planned recipes in the booklet were standardized using appropriate cups and spoons. The raw and cooked weight of the recipes is also documented in the booklet for one serving size. The nutritive value of the recipe is calculated using the latest Indian food composition tables, NIN 2017.

Outcomes

Documentation on time trends of production and consumption of millets.

Consumption pattern of millets among households of people living in urban Vadodara.

Recipe booklet

Statistical analysis

- The data collected was entered in Microsoft Excel, cleaned and analyzed.
- Appropriate statistical analysis was carried out to present the findings.
- Frequency distributions Mean and Percentage were calculated using Microsoft Excel.

RESULTS AND DISSCUSIONS

RESULTS

Millets are coarse cereal grains which are used as food grains and fodder crops. They are high in nutritional value compared to other cereals. They posses several health benefits which aid in prevention of many chronic conditions in human. Millets are generally considered as staple food for the poorer, but these super foods also are considered to help in reducing the burden of malnutrition in many developing countries. Currently awareness and importance of millet consumption is increasing considering the benefits it portraits on the health of the humans and its easy accessibility and improving availability in the markets.

The study was planned with following specific objectives:

- To document the time trends of production of millets in India and Gujarat from the available secondary data source.
- To study the consumption pattern of millets in Gujarat from the available secondary data source.
- To assess the consumption pattern of millets among urban households of selected individuals with their consent in Vadodara.
- To develop 5 recipes each using selected major and minor millets for prevention of NCDs.

The results of the study are presented in following phases:

Phase 1: Documentation time trends in production and consumption of millet in India and Gujarat.

Millets are unique among the cereals as they have a set of characteristics such as growing in dry conditions, relatively poor soils and require less inputs compared to cereals for growing. Millets used as food and fodder consist of better nutritional qualities compared to cereals. They are divided into major millets (pearl millet, sorghum and finger millet) and minor millets (barnyard, foxtail, little, kodo and proso millet). Table 4.1 shows the main millet crops cultivated in India.

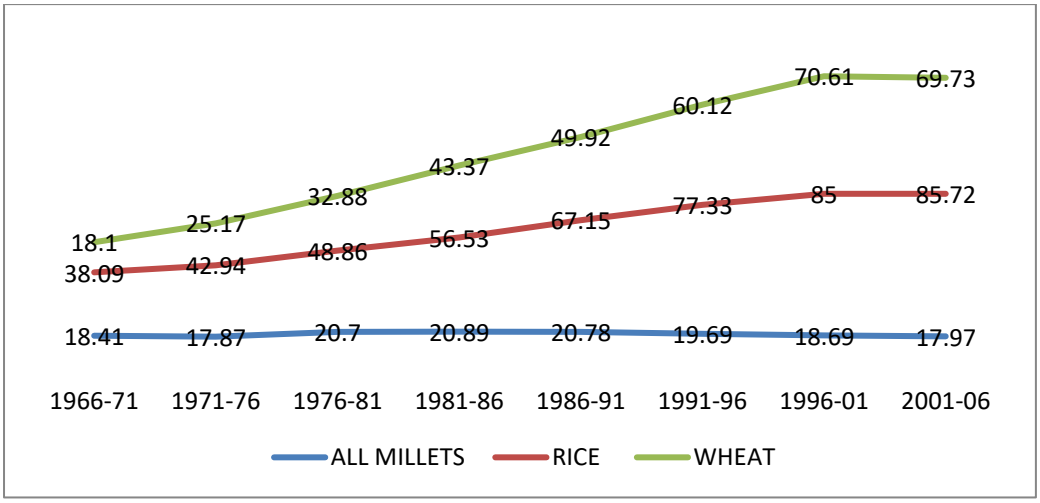
Table 4.1: Millet crops cultivated in India.

Millet crops	Top 5 states producing millets in India
Pearl millet	Rajasthan, Uttar Pradesh, Haryana, Gujarat, Maharashtra
Sorghum	Maharashtra, Karnataka, Madhya Pradesh, Andhra Pradesh, Tamil Nadu
Finger millet	Karnataka, Uttarakhand, Tamil Nadu, Maharashtra, Andhra Pradesh
Barnyard millet	Uttarakhand, Arunachal Pradesh, Nagaland, Madhya Pradesh, Uttar Pradesh
Little millet	Madhya Pradesh, Tamil Nadu, Karnataka, Chhattisgarh, Jharkhand
Kodo millet	Madhya Pradesh, Chhattisgarh, Tamil Nadu, Maharashtra, Uttar Pradesh
Foxtail, Italian millet	Andhra Pradesh, Karnataka, Arunachal Pradesh, Maharashtra, Rajasthan.
Proso millet	Maharashtra, Bihar, Orissa, Rajasthan, Tamil Nadu

Source: Supporting millets in India (policy review & suggestions for actions, 2012)

In India post green revolution the production of millets had been systematically declining. For better understanding of production trends of millets were compared with other crops like wheat and rice which were promoted for intensive farming (Figure 4.1)

Figure 4.1 Post green revolution: millets and other crops in India (1966-06).



Source: Millets future of food and farming (FIAN, India 2015)

In India millets are considered as one of the staple and traditionally consumed food groups which provide various health benefits to individuals and are a nutritional aid in

fighting the food security and malnourishment problem of India and many other developing countries. Millet production had reduced by 1965, with millet production peaking between 1970 and 1973. Millet production had reduced from 1984 to 1987 and a sudden increase was seen from 1989 to 1993. Until 2000, millet production remained stable in 2002 and millet production reduced in 2009, since then millet production has reduced until 2019. (Figure 4.2, figure 4.3, figure 4.4, figure 4.5, figure 4.6, figure 4.7)

The production of Jowar, Bajra and Nutri cereals declined in 2002-03, 2009-10 and 2015-16, followed by the increase in the production of bajra and nutri cereals in 2003-04 and 2010-11. Production of jowar was stable until 2014-15, but gradually reduced from 2015-16 until 2018-19 (figure 4.8). In India the trend in area, production and yield of millets is showing decreasing trend from 1950-51 to 2018-19. (Figure 4.9)

Millet cultivation scenario in Gujarat

The cultivation systems of a region are determined by a number of parameters such as soil type, temperature, precipitation, etc. In addition to these factors, other factors such as infrastructural facilities (irrigation, transportation, storage facilities, etc.), socio-economic factors and technological developments help in deciding the agricultural system of a particular region. Gujarat is divided into five regions, namely the South, Central, North, Saurashtra and Kutch. Seven agro-climatic regions were identified here based on soil properties and temperature. These are South Gujarat (heavy rain zone), South, Central, North, South Saurashtra, North Saurashtra and North – West Arid (Kutch). Technological changes have favored water-intensive crops. So the cultivation pattern of Gujarat has changed since 1960. Changes have harvested such as cotton, rice, etc. are favored at the expense of the areas planted with pulses, oilseeds and coarse grains, which are due to agro-climatic conditions, technological changes, institutional changes and infrastructure changes related to agriculture in recent years. These changes could possibly be attributed to the following factors: energy supply, agricultural inputs such as fertilizers, water supply (rain or irrigation), and the type of cultivation pattern that determines the duration of cultivation activities during a particular crop. Food grain production in Gujarat increased from 1.8 million tons in 1960-61 to 8.2 million tons in 2007-08 (a 76.9 percent increase was observed between 1960-61 and 2007-08), although there has been little

increase in the net area planted since 1960. Gujarat accounts for about five percent of India, but only about four percent of total Indian food production. Table 4.2 shows the cultivation of millets in 7 different zones of Gujarat along with the districts and major crops grown. The cropping pattern of food grains and millets in 2008-09 can be observed in figure 4.10. The colors blue, whitish grey, brown, boxes, red, grey and baby pink depicted the production of bajra and jowar in those regions.
The production of jowar was stable, while production of bajra had increased in between 2015 to 2019 in Gujarat. Nutri –cereals production peaked in 2016-17 but had declined in Gujarat in 2018-19 (figure 4.11). The production of bajra was more compared to jowar, ragi and other small millets in Gujarat in 2019-2020 (figure 4.12).

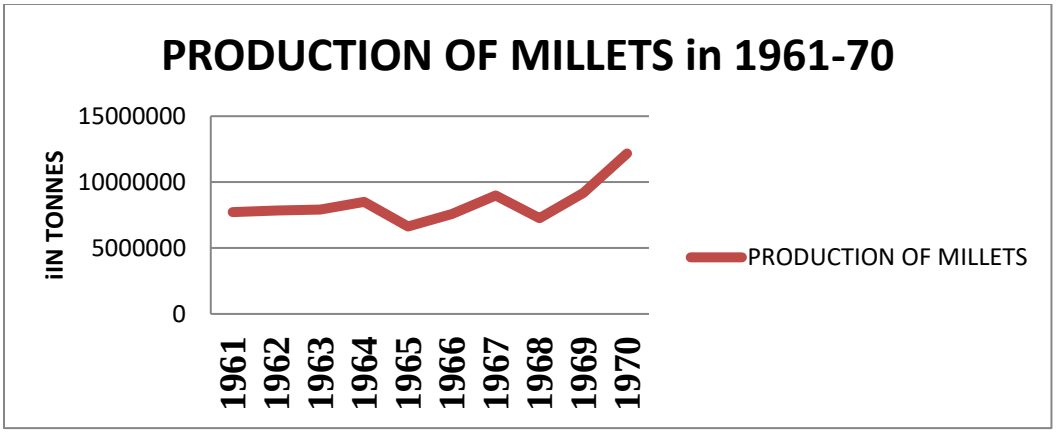
Consumption pattern of millets in India and Gujarat

Since history in India, millets have been consumed. In time, the use of millet decreased as a result of the green revolution, promoting cereal grain production such as wheat and rice to strengthen the economy. This resulted in a reduction in millet output, and hence a decrease in millet consumption. Awareness of millet consumption and its therapeutic properties at national and worldwide level is being pushed in today's context. However, there is a declining tendency from 2006-2017 in millet consumption. (Figure 4.13)

The trend in consumption pattern of millets overall was decreasing due to attributing factors such as changing food habits, growing urbanization, increased incomes, competition from other crops, millets being known as poor man’s crops, the time-consuming process of de-hulling process and lack of modern based millet foods in the market .

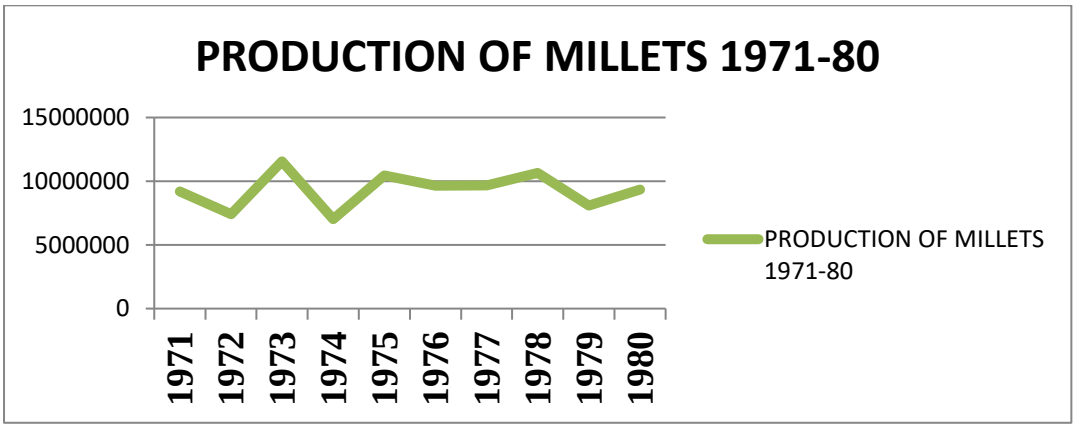
The consumption of small millets in India was highest in Assam and Bihar (Figure 4.14) and consumption of finger millets was observed in states Bihar, Karnataka, Maharashtra and Gujarat (Figure 4.15).

Figure 4.2 Production of millets in 1961-70 in India.



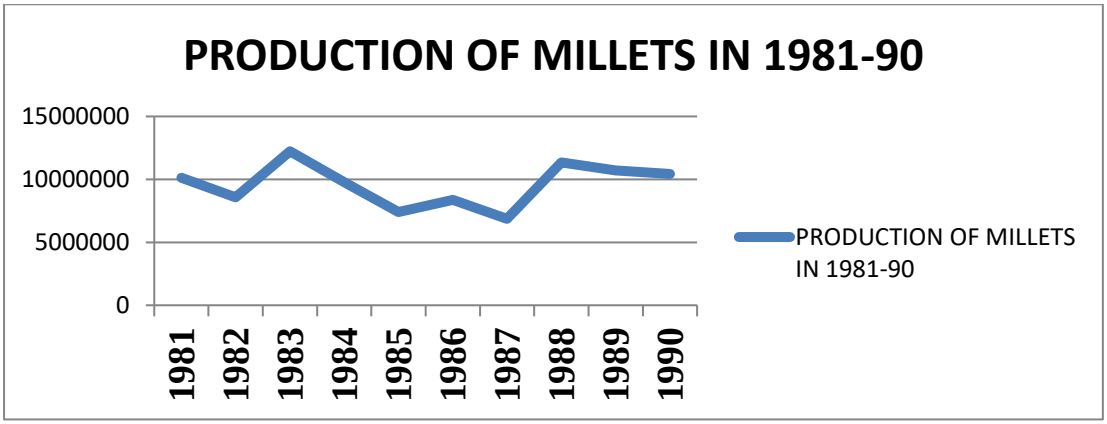
Source: FAO, 2021

Figure 4.3: Production of millets in 1971-80 in India.



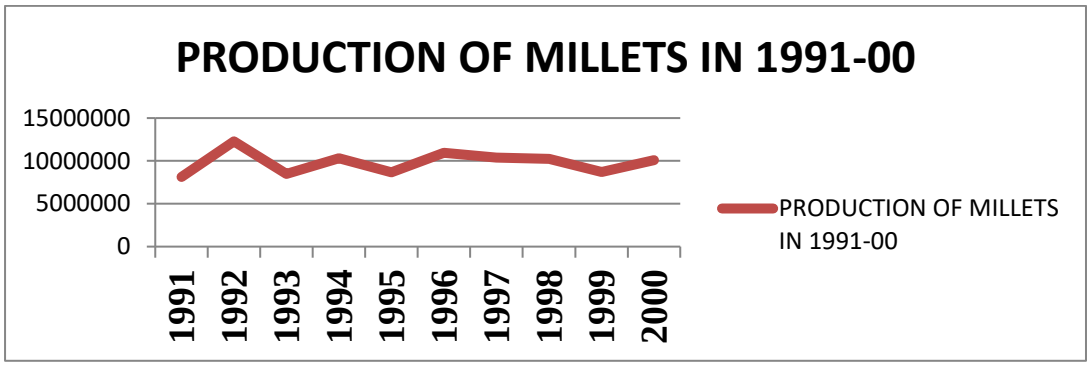
Source: FAO, 2021

Figure 4.4: Production of millets in 1981-90in India.



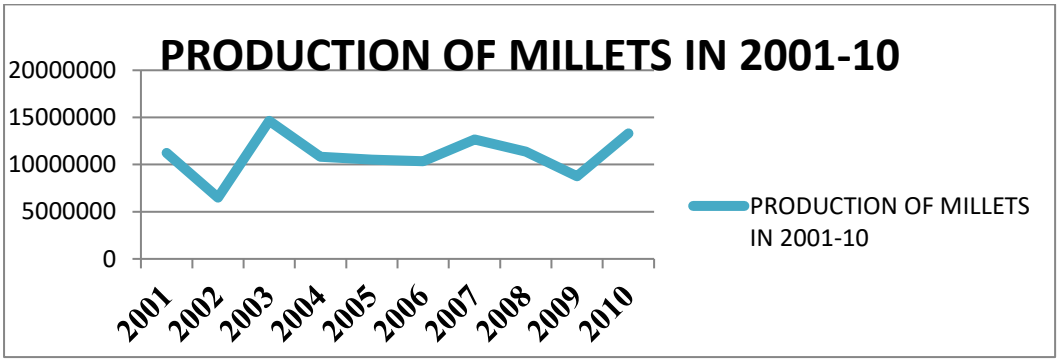
Source: FAO,2021

Figure 4.5 Production of millets in 1991-2000 in India.



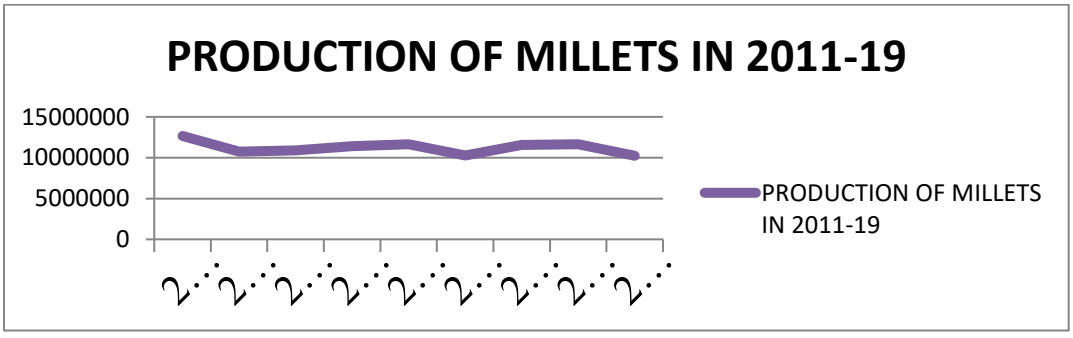
Source: FAO,2021

Figure 4.6: Production of millets in 2001-10 in India.



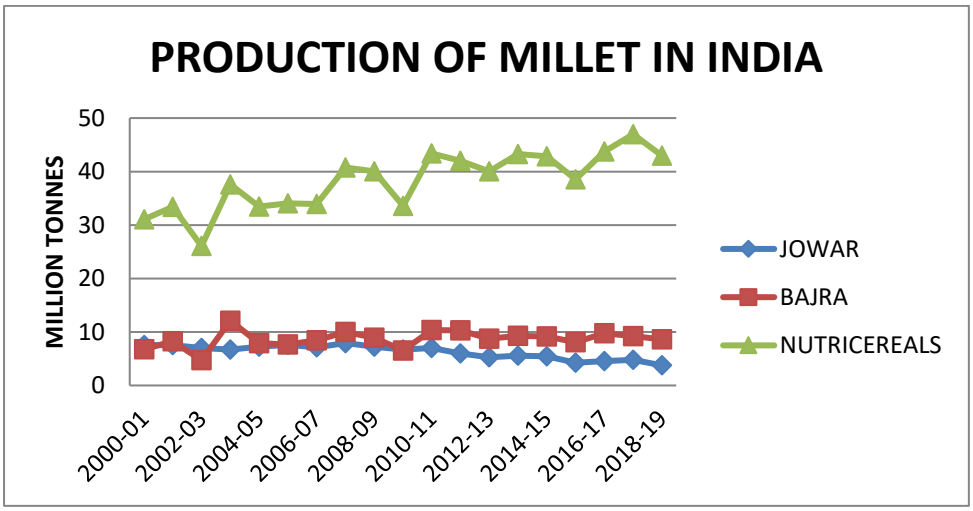
Source: FAO, 2021

Figure 4.7: Production of millets in 2011-19 in India.



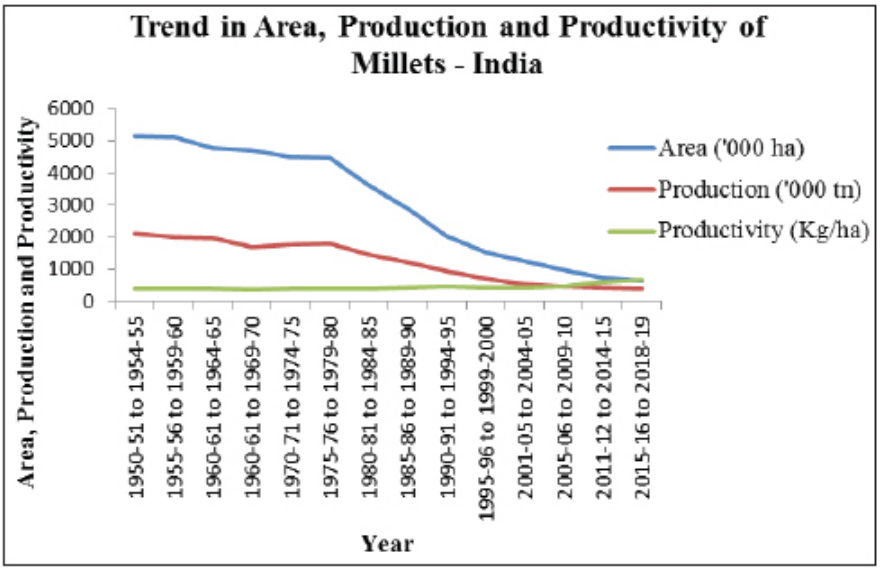
Source: FAO,2021

Figure 4.8 Production of jowar, bajra and nutri- cereals in India (2001-19).



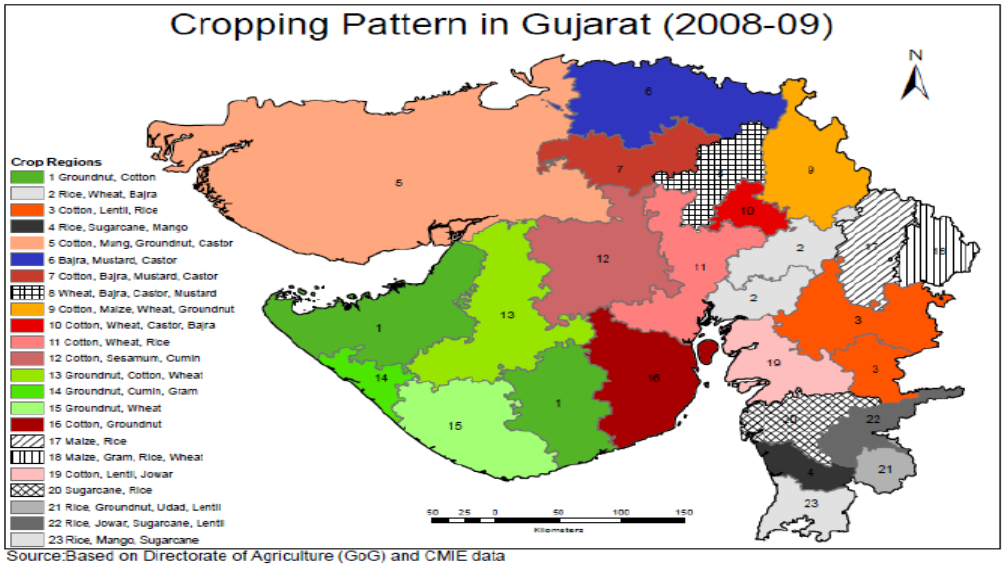
Source: Agricultural statistics 2018-19

Figure: 4.9: Trend in area, production and yield of millets in India (1950-51-2018-19)



Source: Millet scenario in India, Gowari and Shivkumar (2020)

Figure 4.10 Cropping pattern in Gujarat in 2008-09.



Source:Based on Directorate of Agriculture (GoG) and CMIE data

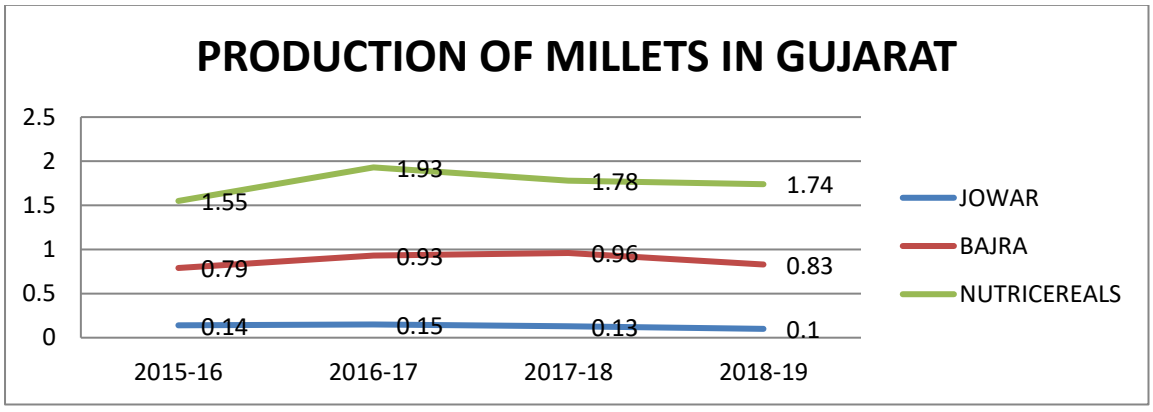
Table 4.2: The following table shows the cultivation of millets in 7 different zones of Gujarat along with the districts and major crops grown.

Zone	District covered	Major crops
South Gujarat (Heavy Rain Area.)	Navsari, Dang, Valsad and Valod, Vyara, songadh and Mahuva taluks of Surat.	Rice, Sorghum, Ragi, Kodra, Sesame, Pigeon pea, Groundnut, Cotton, Sugarcane, Chilies, Wheat, Gram
South Gujarat	Surat and Amod, Ankleshwar, Broach, Dekdopada, Honsot, Jhagadia, Nanded, Sagbara and Valia talukas of Bharuch	Rice, Wheat, Gram, Pearl millet, Sorghum, Maize, Kodra, Ragi, Pigeon pea, groundnut, Sesame, Castor, Cotton, Sugarcane, Chilies,
Middle Gujarat	Panchmahals, Baroda and Anand, Balasinor, Borsad, Kapadvanj, Kheda, Matar, Ahmedabad, Nadiad, Petlad and Thasara and taluks of Kheda.	Rice, Wheat, Gram, Pearl millet, Sorghum, Maize, Kodra, Ragi, Pigeonpea, groundnut, Sesame, Castor, Cotton, Sugarcane, Potato, Rapeseed & Mustard.
North Gujarat	Sabarkantha, Gandhinagar, Dehgam, Daskroi, Sanand talukas of Ahmedabad, Deesa, Dhenera, Palanpur, Dandta, Wadgam taluks of Banaskantha and Chanasma,	Rice, Wheat, Gram, Pearl millet , Sorghum, Maize, groundnut, Sesamum, Castor, Cotton, Sugarcane, Cumin, Rapeseed & Mustard.

	Kadi, Kalol, Kheralu, Mehsana, Patan, Sidhpur, Visnagar, Vijapur taluks and Mehsana.	
Bhal & Coastal Area	Bhavnagar (Vallabhipur, Bhavnagar talukas), Ahmedabad (Dholka, Dhanduka talukas), and Vagra, Jambusa talukas of Bharuch.	Rice, Pearl millets.
South Saurashtra	Junagadh, Ghodha, Talaja, Mahava taloukas of Bhavnagar Kodinar, Rajula and Jafrabad talukas of Amerli and Dhoraji, Jetpur, Upleta talukas of Rajkot.	Rice, Maize, Sugarcane Wheat, Gram Pearl millet ,Sorghum, Groundnut, Sesame, Cotton, Pulses, rapeseed & Mustard
North Saurashtra	Jamnagar, Rajkot, Chotila, Limdi, Lakhtar, Muli, Sayla, Wadhwan talukas of Surendranagar and Gadheda, Umrala, Botad, Kundla, Dihor, Garidhar, Palitana talukas of Bhavnagar and Amreli, Babra, Lathi, Lalia, Kunkavav, Khamba, Dhari taluks of Amreli.	Pearl millets, Sorghum, Groundnut, Seasamum, Castor, Cotton, Pulses
North West Zone	Kutch, Rajkot, Malia Halvad, Dhrangdhra, Dasada taluks of Surendranagar, Sami and Harij taluks of Mahsana, Santhalpur, Radhanpur, Kankrej, Deodar, Vav, Tharad taluks of Banaskantha and Viramgam taluka of Ahmedabad	Rice, Wheat, Gram, Pearl millet, Sorghum, Maize, Pigeon pea, groundnut, Sesame, Castor, Cotton, Rapeseed & Mustard, barley.

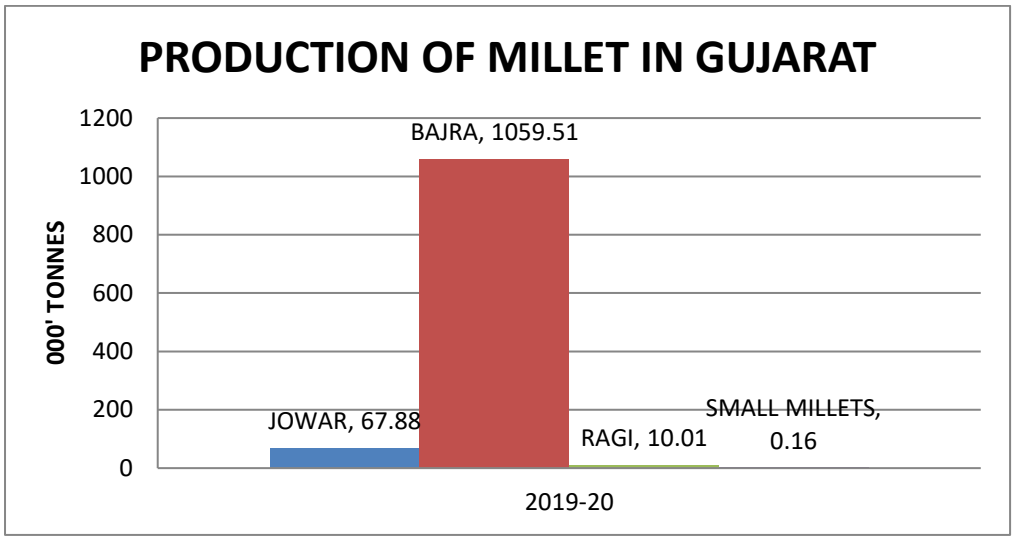
Source: AERC Report 2012

Figure 4.11: Production of millets in Gujarat (2015-19)



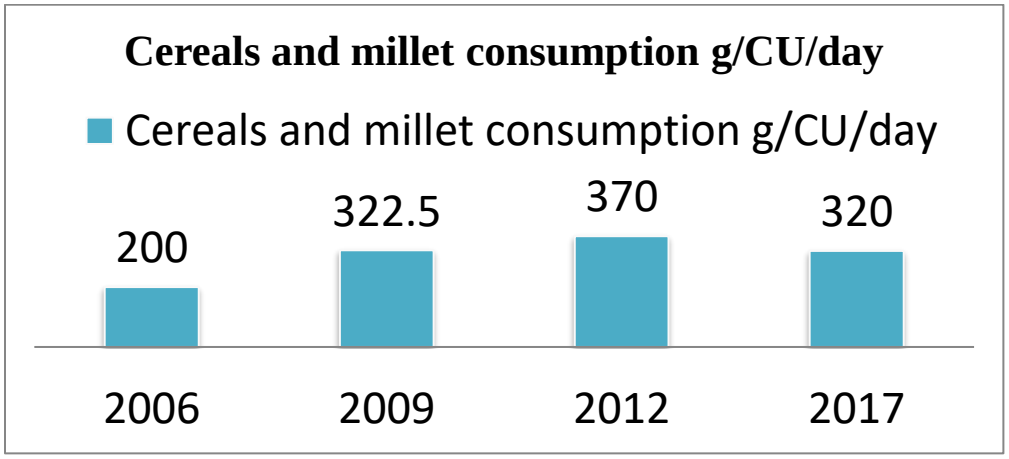
Source: Agricultural statistics report 2018-19.

Figure 4.12: Production of millets in Gujarat in 2019-2020.



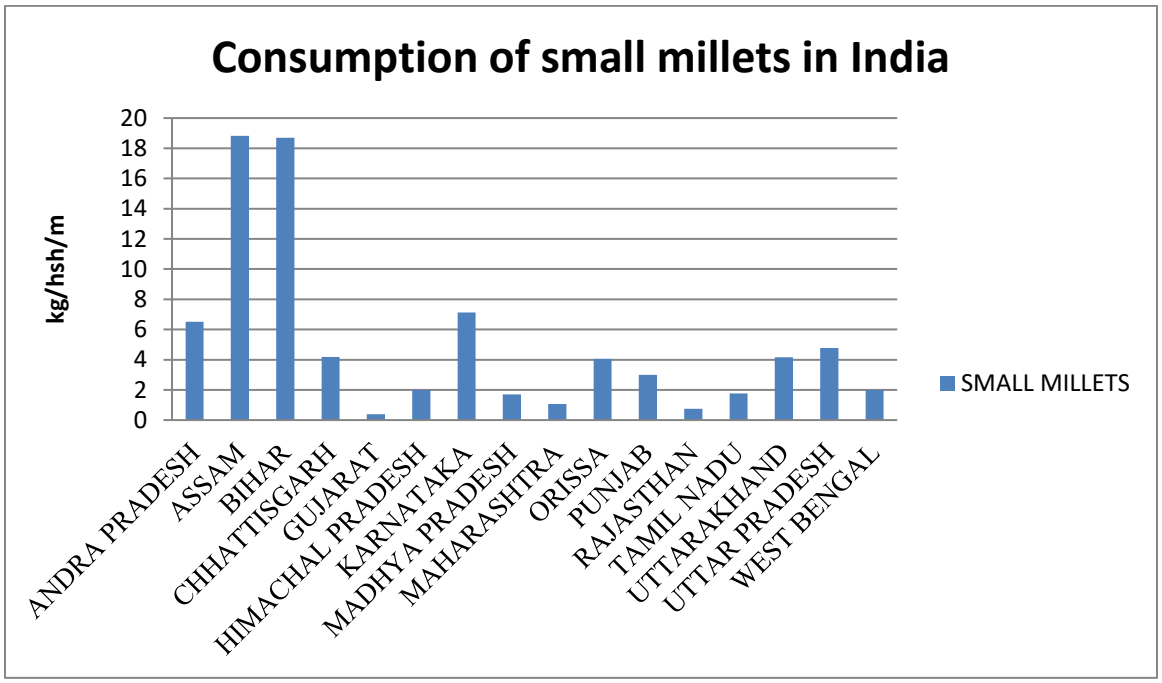
Source: Agricultural statistics report 2019-20.

Figure 4.13: Cereals and millet consumption in India (2006-2017)



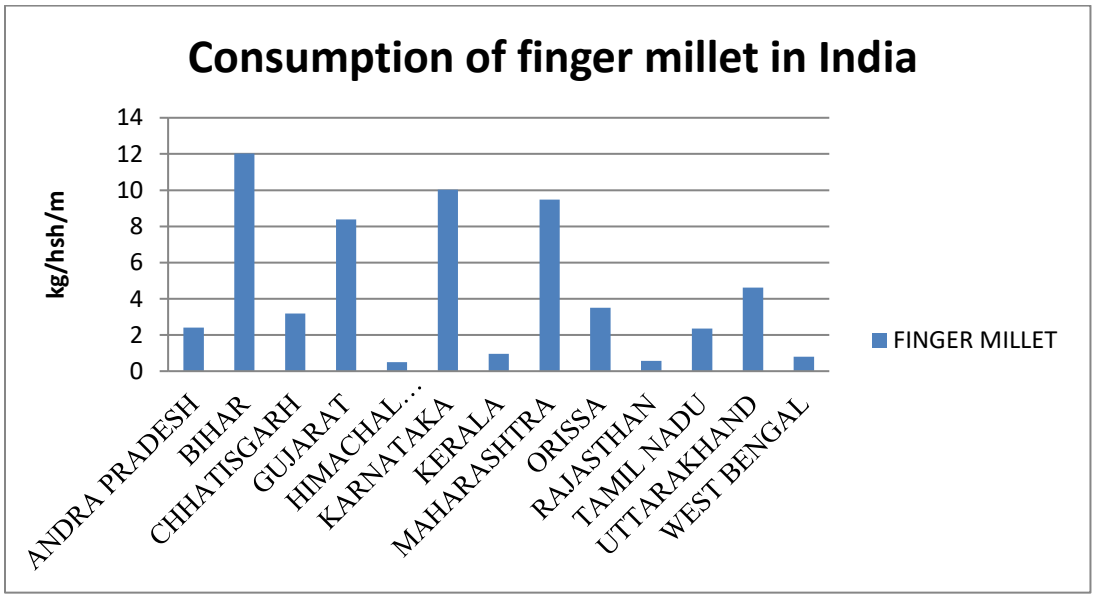
Source: NNMB reports (2006, 2009, 2012, 2017)

Figure 4.14: Consumption pattern of small millets in India (2011-12).



Source: Anbukkani et al, 2017

Figure 4.15: Consumption pattern of finger millet in India (2011-12).



Source: Anbukkani et al, 2017

Highlights

- Production of millet in India and Gujarat shows decreasing trend.
- Bajra is the most common millet grown and consumed in Gujarat.
- Consumption pattern of millet also shows decreasing trend in India and Gujarat.

Phase 2: Consumption pattern of millets in urban households of Vadodara.

Background information of households and respondents

The background information about the households was obtained using pre tested semi-structured questionnaire. Data regarding type of family, family size, ethnicity, religion and occupation of the head of the household were collected. The background information is presented in table 4.3. In the study it was observed that 70% of the families were nuclear families and 71 per cent of them had family size up to 4 members (figure 4.16 and figure 4.17). The family composition in the households is presented in figure 4.18. The majority of the respondents were Hindu (98%) and approximately 50% of them were Gujarati, 37% of them were others (native of Rajasthan, Uttar Pradesh, Bihar and Punjab) (figure 4.19). Nearly 74% of the heads of the household had private jobs in the study (figure 4.20). Females of enrolled households were the respondents for the study and about 47% of them were between ages 41 to 50 years. About 43% of the female respondents had done there graduation and 80% of them were housewife (table 4.4).

Co- morbidities among the members of households

It was thought worthwhile to elicit information about presence of any NCDs related co-morbidities in the family. It was reported that nearly 62% of the respondents had family members who had co-morbidities such as obesity, diabetes, heart related problems etc. High blood pressure and diabetes was mostly observed in the households (figure 4.21).

Awareness and common millets known to respondents

It was found that 99 percent of the respondents were aware about millets and mostly commonly known millet was pearl millet (figure 4.22). Nearly 87 percent of the respondents were aware about the benefits of millet consumption as most of them considered millets to provide health benefits, increase fiber in the diet, lowers blood sugar and lowers lipid profile (figure 4.23). 73.56 percent of the respondents were aware about the benefits of millet consumption based on the knowledge provided them by their family and friends. 10.34 percent and 2.29 percent of the respondents relied on the

doctors and nutritionist/ dietician respectively. Other relied on sources like print media, television for knowledge and awareness regarding benefits of millet consumption.

Purchasing pattern of millets in the households

Nearly 84 percent of the respondents purchased millets from the market whereas 11 percent of the respondents had their own farm produced millets. Mostly commonly bajra was purchased and millets were purchased as per the requirements of the respondents in their households (figure 4.24 and figure 4.25) It was found that only 13 per cent of the households preferred to purchase readymade products of millets from the market such as chips, chakli, ladoo thepla and biscuits.

Consumption pattern of millets in households

The consumption pattern of millets among the100 households was found to be 95 percent. Among all the millets bajra 86.45% (Figure 4.26) was most commonly consumed in the households in the form of rotla, roti or debra compared to other millets. It was found that in majority all the members of the family in the households consumed millets on weekly basis (Figure 4.27). Most of the respondents consumed millets for its health benefits and for variation of taste in their diets (Figure 4.28). Nearly 83% of the respondents consumed millets a week prior to the survey and 53% of the respondents consumed millets a month prior to the survey.

Consumption of millets during fasting

During fasting 53% of the respondents consumed millet like samo (35.84%), moriyo (75.47%) and rajgira (49.05%) in the form of recipes like khicdi, kheer, puri, halwa, sheera, etc. Nearly 52.83% of the respondents consumed millets during fasting because of religious beliefs and 47.16% of respondents consumed millets during fasting due to traditional practices in their family.

Consumption of samo by female members of the households

Nearly 43% of the female members of the households consumed samo up to 50 to 150 g due to traditional practices in their families.

Millet preparations for special groups and occasions and in Covid 19 pandemic

Nearly 15% of the respondents prepared special recipes from millets for age group like pregnant and lactating mothers, children and elderly. During festive occasion mostly millets were prepared on Ganesh chaturthi(43%), uttarayan(27%), shravan(12%), holi (4%) and others(8%). Only 23% of the respondents had prepared new recipes from millets during the Covid 19 pandemic.

Millet cost and perception of respondents

Around 75% of the respondents consider that millets are not expensive when compared with cereals like wheat and rice. But out of 75 percent respondents 28%, 24% and 20% of them also consider that rajgira, moriyo and kodari are expensive when compared with cereals respectively.

To understand the dietary pattern, meal pattern and consumption of millets, 24 hour dietary recall was done. Information was collected from the households. It was reported that 59% of the households in the study had the practice of consuming vegetarian diet, 29% of households consumed non- vegetarian diet and 12% of households consumed ovo- vegetarian diet. It was observed that in all the 100 households all the three major meals (breakfast, lunch and dinner) were consumed on daily basis whereas only 65% , 26%, 19% and 17% of the households had prevalence of consuming snacks, bedtime, early morning and mid-morning meals on regular basis.

Frequency of millets consumed in the households

The frequency of millet consumption was observed that hardly any of the households consumed millets on everyday basis but nearly 30% of the respondents consumed bajra once a week whereas only 23% of them consumed jowar once a month. 20% and 19% of the respondents rarely consumed finger millet (ragi) and koadri in their diet. It was also observed that 37% and 27% of the respondents consumed barnyard millet and amaranth occasionally and hardly any respondents consumed other millets on regular basis in the diet (figure 4.29 & figure 4.30).

Household dietary diversity (HDD)

Household dietary diversity (HDD) is number of different food groups consumed over a given reference period. The number of different food groups consumed is calculated, rather than the number of different foods consumed. The following set of twelve food groups is used to calculate the HDDS.

A. Cereals	G. Fish and seafood
B. Roots and tubers	H. Pulses/legumes/nuts
C. Vegetables	I. Milk and milk products
D. Fruits	J. Oil/fats
E. Meat, poultry	K. Sugar/ honey
F. Eggs	L. Miscellaneous

In the study the household dietary diversity was calculated using the 12 food groups. Additional food group millet was added in the study for better understanding of millet consumption in the urban households of Vadodara (Figure 4.31).

The figure 4.26 depicts household dietary diversity of households in urban Vadodara. It was observed that consumption of food groups such as cereals, milk and milk products, oil/fats and sugar/honey was 100 percent, whereas consumption of roots and tubers was 82 percent, vegetables was 99 percent, pulses/ legumes/ nuts was 92 percent and fruits was 39 percent.

It was thought worthwhile to analyze millet consumption, by the households with presence of co-morbidities in the family, age, education, occupation status of the respondent. The findings are presented in figure 4.32 and figure 4.33 It can be seen that all most all the respondents reported that their family members with co-morbidities like high blood pressure and diabetes consume millets. However frequency of regular consumption of millets was not reported. With regards to age, years of education and occupation status did not show much difference in consumption of millets.

To determine the factors which affect consumption of millets around nine appropriate factors were selected which are occupation of head of the household (Figure 4.34), ethnicity (Figure 4.35), type of family (Figure 4.36), total members in family (Figure 4.37), medical history of family members in households (Figure 4.38), awareness about millets (Figure 4.39), awareness about benefits of millet consumption in households (Figure 4.40), type of diet (Figure 4.41), income (Figure 4.42) and age of respondents (Figure 4.43). It was found that out of all the nine factors significant association between medical history of family members in households and consumption of millets was seen (Figure 4.38).

Table 4.3: Background information of the households.

Sr. no.	Particulars	N	%
1	**Type of family**		
	a) Nuclear	70	70%
	b) Joint	10	10%
	c) Extended Nuclear	20	20%
	Total	100	100
2	**Family size**		
	a) upto 4	71	71%
	b) 5 to 7	26	26%
	c) 8 and more	3	3%
	Total	100	100
3	**Ethnicity**		
	a) Gujarati	53	53%
	b) Marathi	7	7%
	c) Kathiyawadi	3	3%
	d) Others	37	37%
	Total	100	100
4	**Religion**		
	a) Hindu	98	98%
	b) Muslim	-	-
	c) Christian	-	-
	d) Others	2	2%
	Total	100	100
5	**Occupation of head of the household**		
	a) Service	74	74%
	b) Business	19	19%
	c) Government employee	2	2%
	d) Housewife	-	-
	e) Others	5	5%
	Total	100	100

Figure 4.16 Type of family distribution

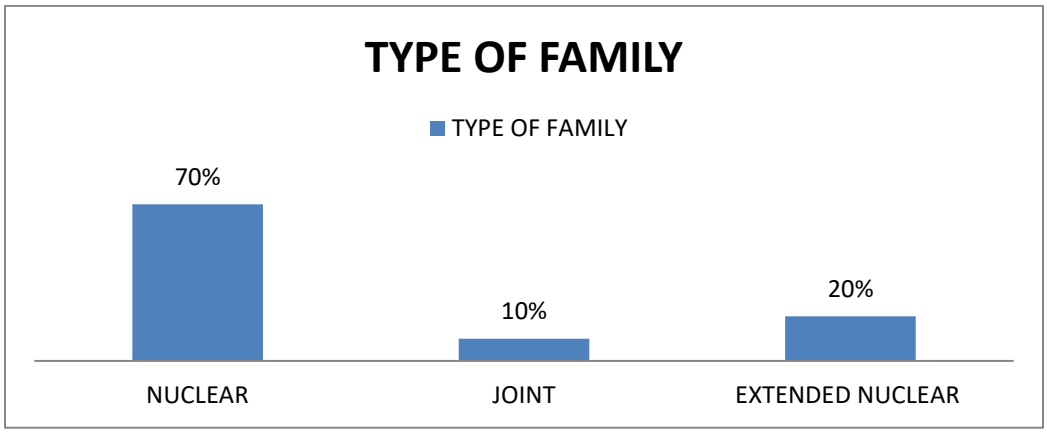


Figure 4.17: Family size distribution.

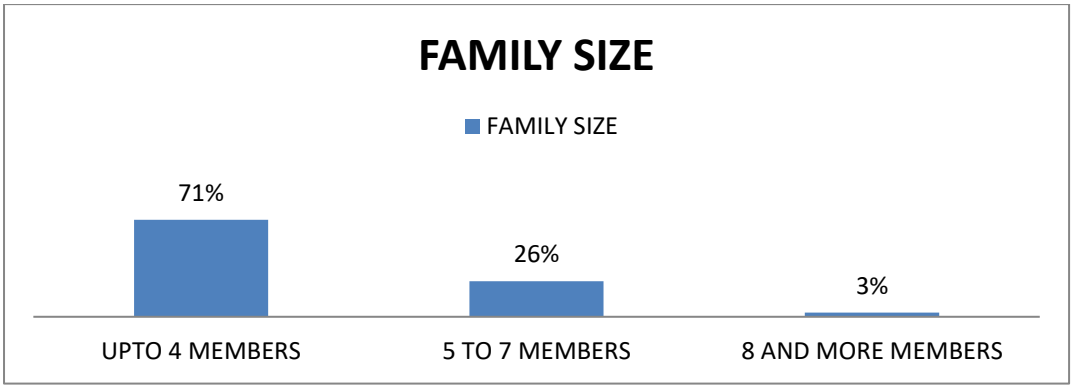


Figure 4.18: Family composition in the household's distribution.

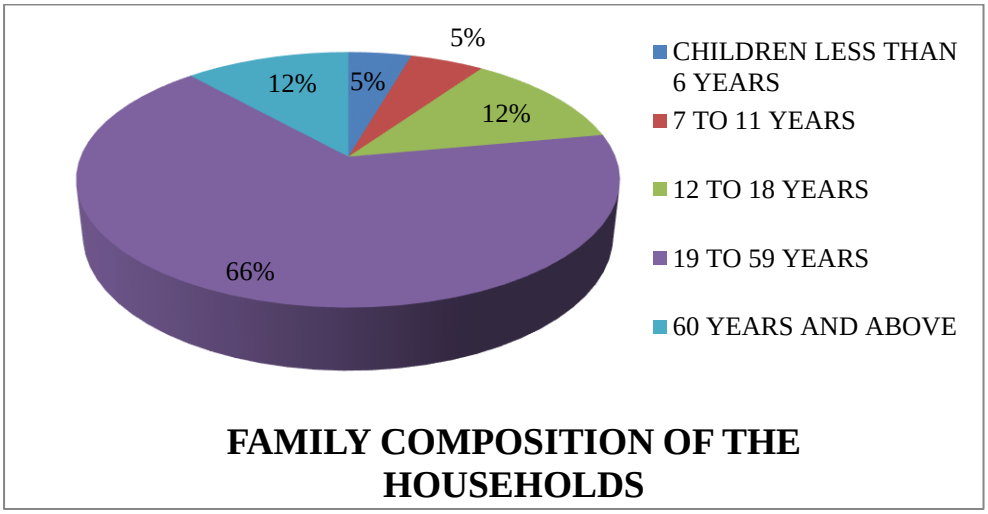


Figure 4.19: Ethnicity distribution

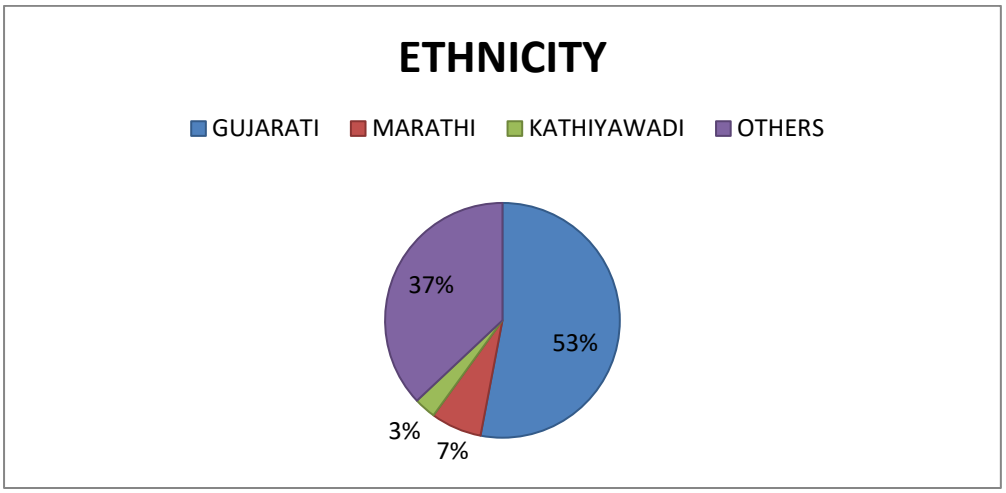


Figure 4.20: Occupation of head of the household distribution

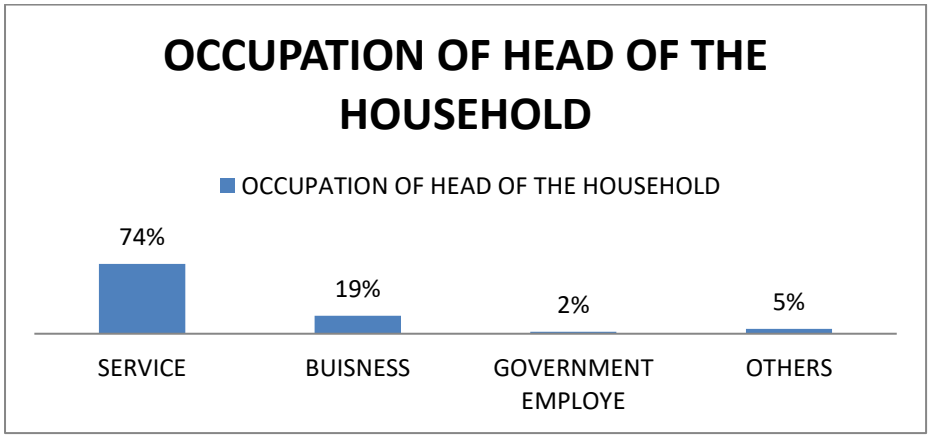


Figure 4.21: Presence of medical conditions in family members of the households.

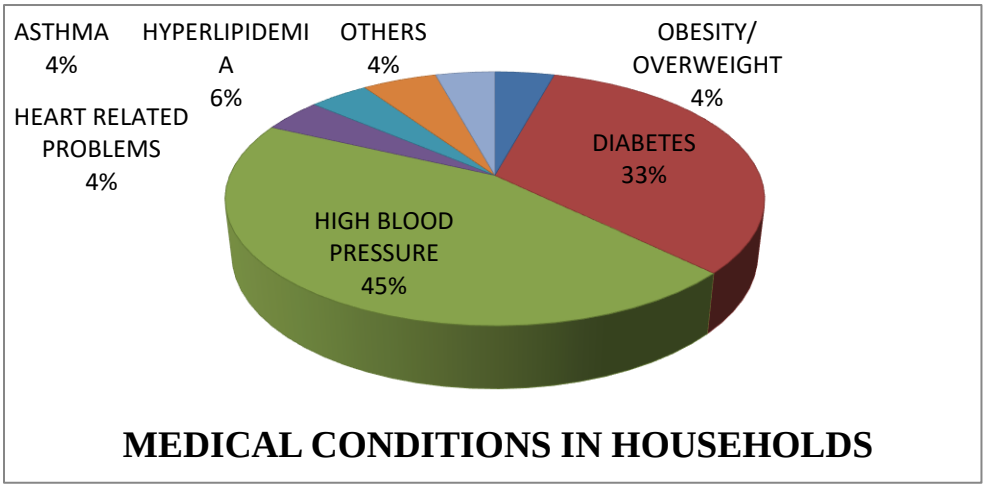


Table 4.4 Information on respondents

Sr. no.	Particulars	N	%
1	**Respondents (All females)**	100	100%
2	**Age of the respondent**		
	a) 18 to 30 years	13	13%
	b) 31 to 40 years	28	28%
	c) 41 to 50 years	47	47%
	d) 51 years and above	12	12%
	Total	100	100
3	**Education of respondent**		
	a) Illiterate	6	6%
	b) Primary	4	4%
	c) Secondary	10	10%
	d) 10^{th} pass	13	13%
	e) 12^{th} pass	17	17%
	f) Graduate	43	43%
	g) Post- graduate	7	7%
	Total	100	100
4	**Occupation of respondent**		
	a) Service	10	10%
	b) Business	9	9%
	c) Government employee	-	-
	d) Housewife	80	80%
	e) Others	1	1%
	Total	100	100

Figure 4.22: Common millets known by the respondents

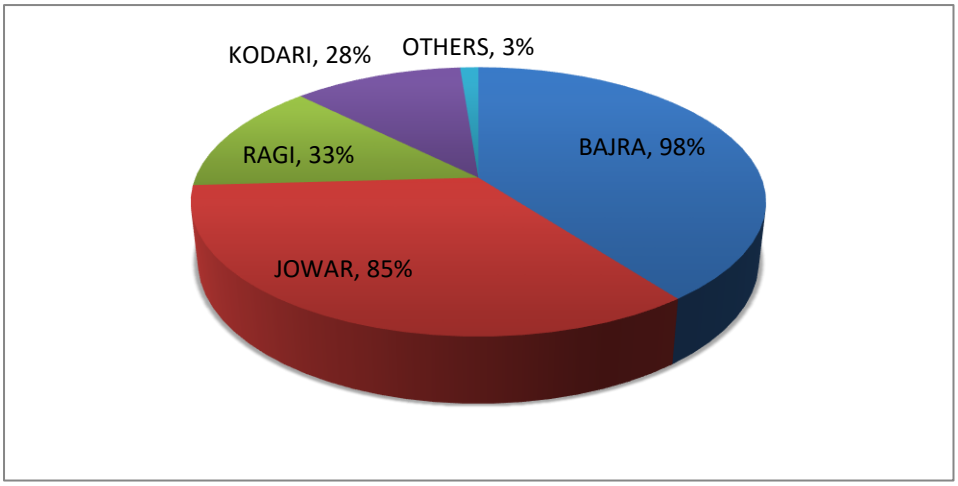


Figure 4.23: Awareness about benefits of millet consumption

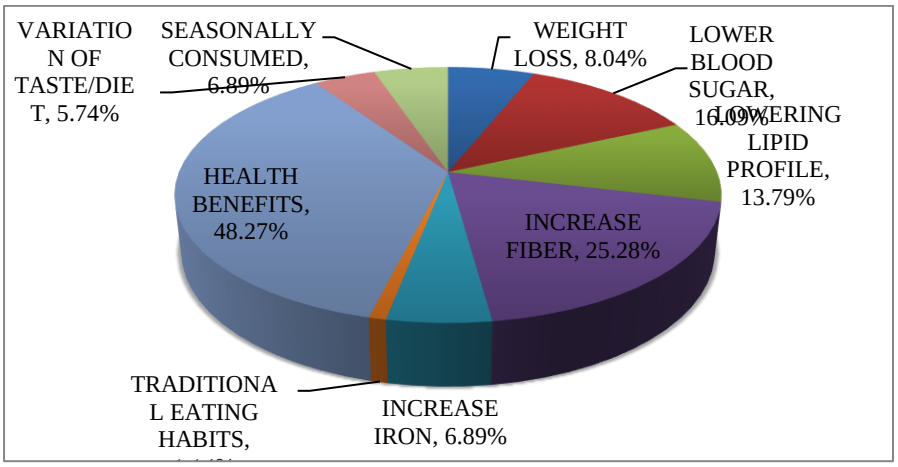


Figure 4.24: Most commonly purchased millets in the households

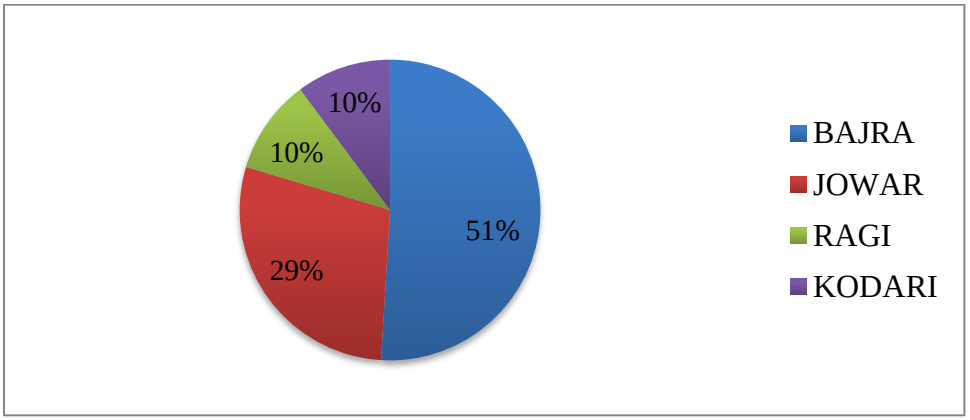


Figure 4.25: Frequency of millet purchased in the household distribution.

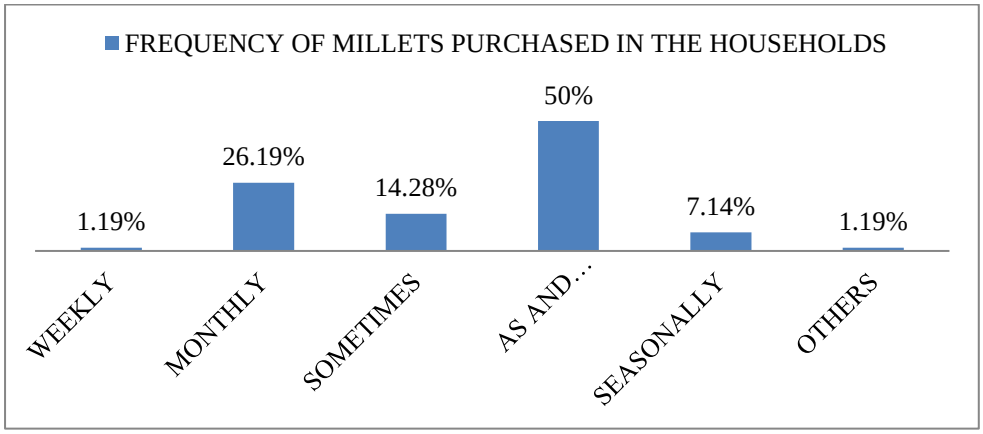


Figure 4.26: Most commonly consumed millets in household's distribution

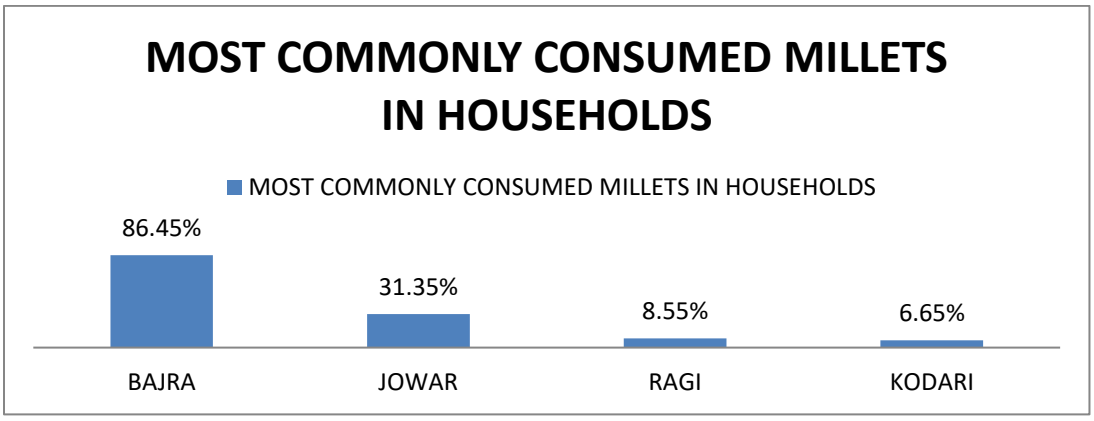


Figure 4.27: Frequency of millets consumed in the households distribution.

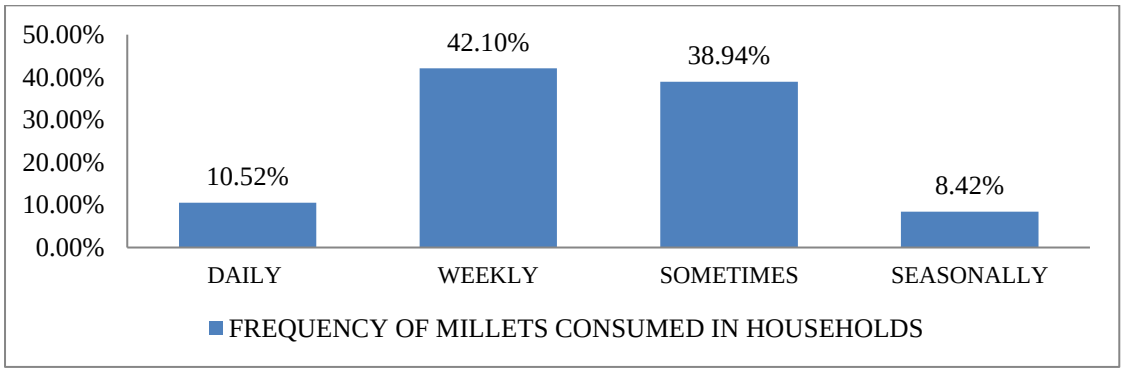


Figure 4.28 Purpose of millet consumption in the household's

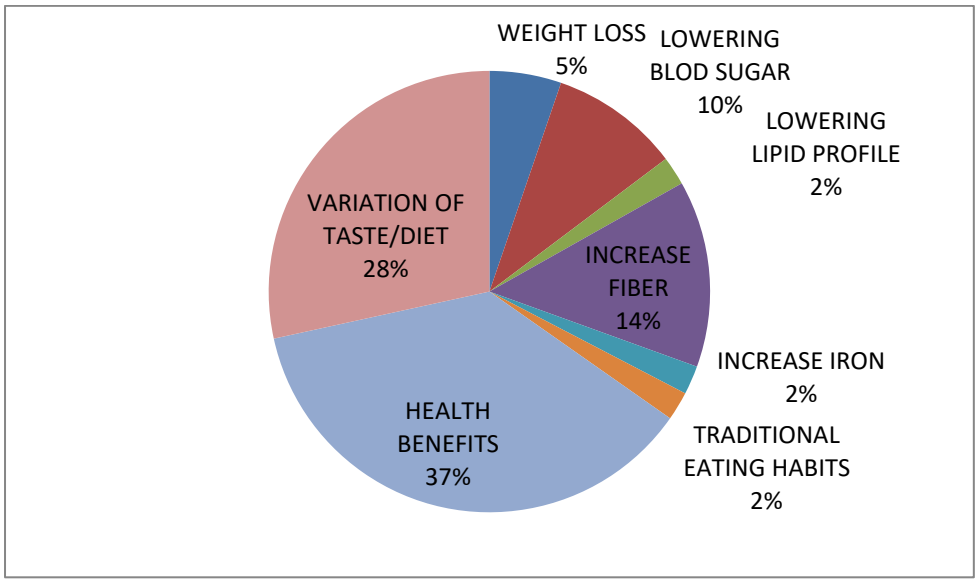
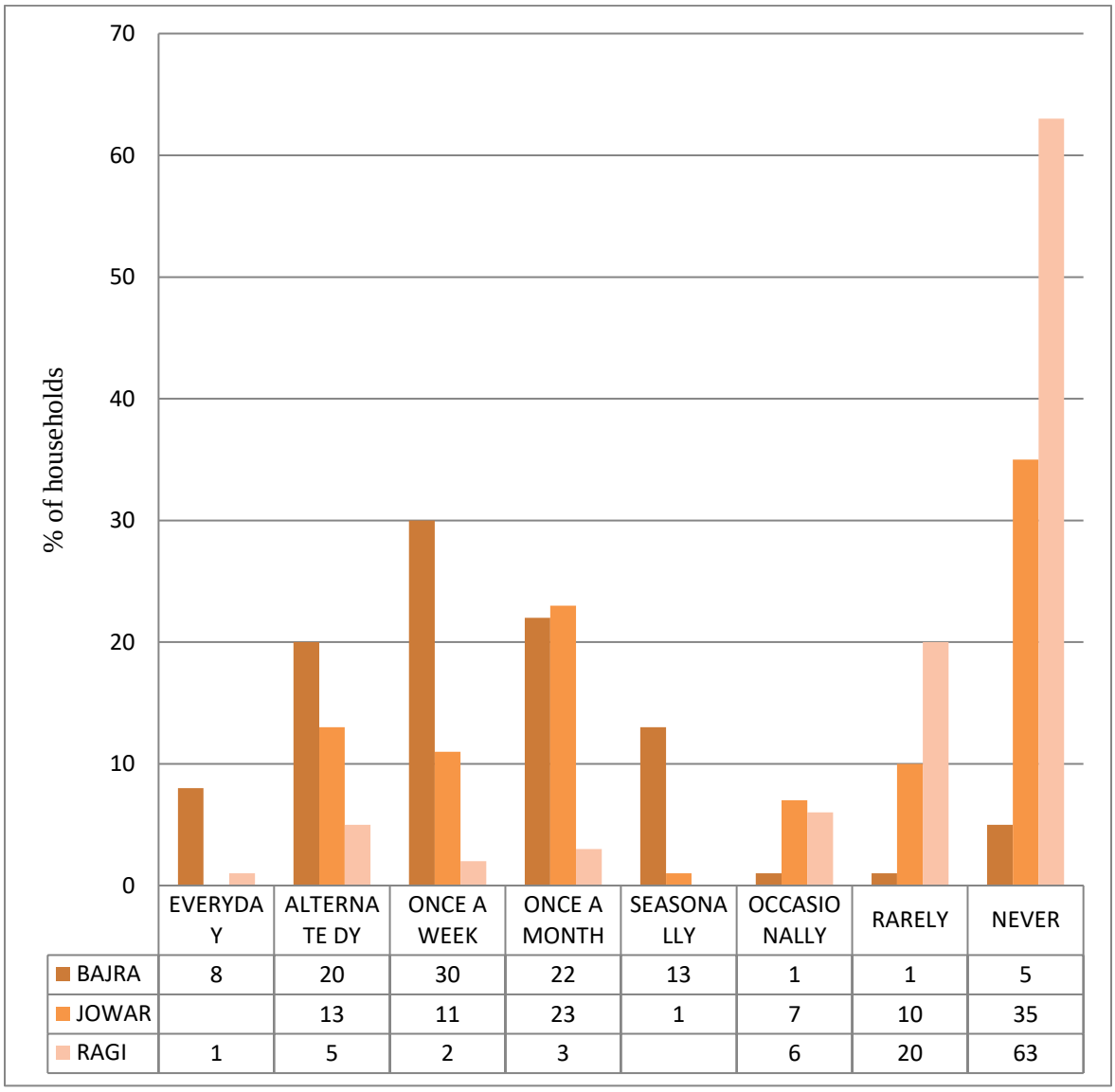
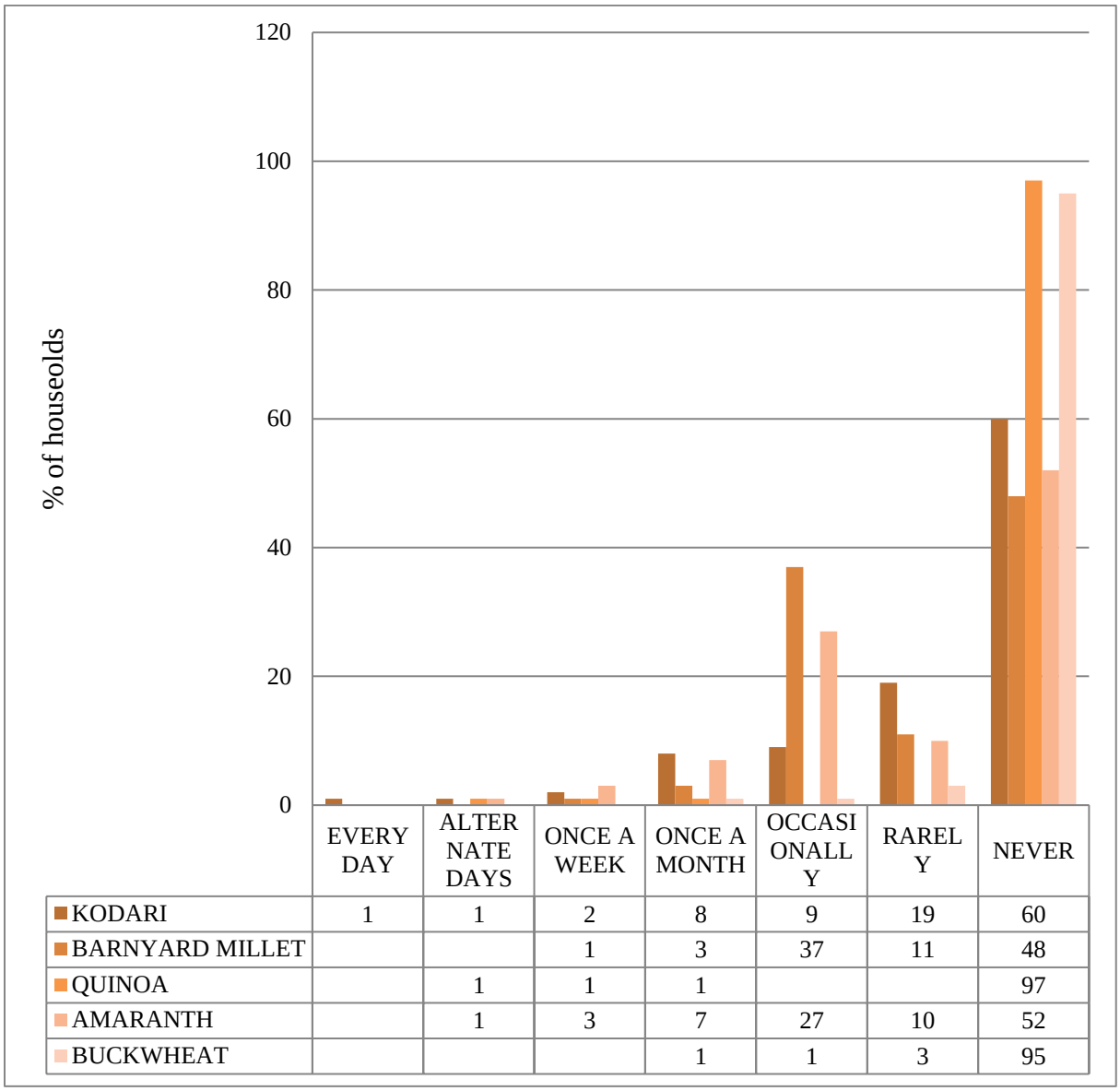


Figure 4.29: Frequency of major millets consumed in the households distribution.



	EVERYDAY	ALTERNATE DY	ONCE A WEEK	ONCE A MONTH	SEASONALLY	OCCASIONALLY	RARELY	NEVER
BAJRA	8	20	30	22	13	1	1	5
JOWAR		13	11	23	1	7	10	35
RAGI	1	5	2	3		6	20	63

Figure 4.30: Frequency of minor and pseudo millets consumed in the households



	EVERY DAY	ALTER NATE DAYS	ONCE A WEEK	ONCE A MONTH	OCCASI ONALL Y	RAREL Y	NEVER
KODARI	1	1	2	8	9	19	60
BARNYARD MILLET			1	3	37	11	48
QUINOA		1	1	1			97
AMARANTH		1	3	7	27	10	52
BUCKWHEAT				1	1	3	95

Figure 4.31 Household dietary diversity of households in urban Vadodara

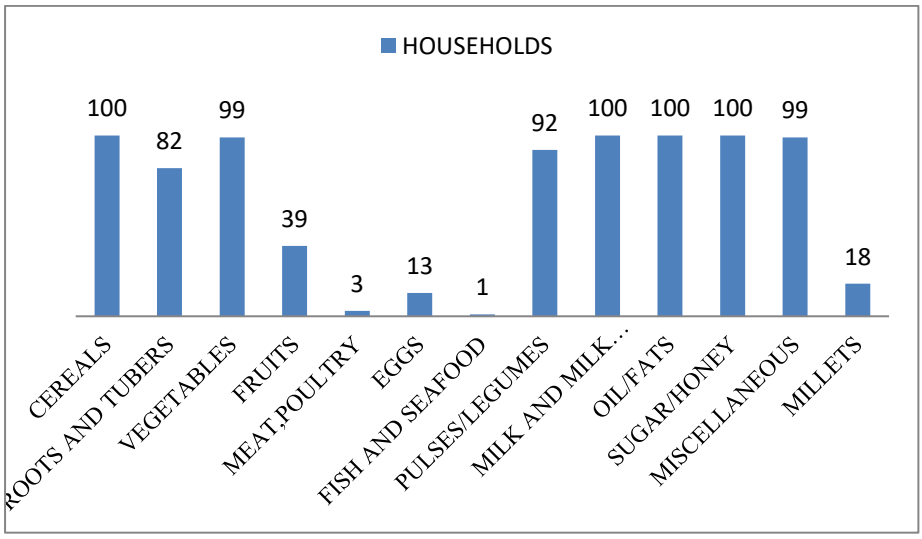


Figure 4.32: Millet consumption by the family members having co-morbidities.

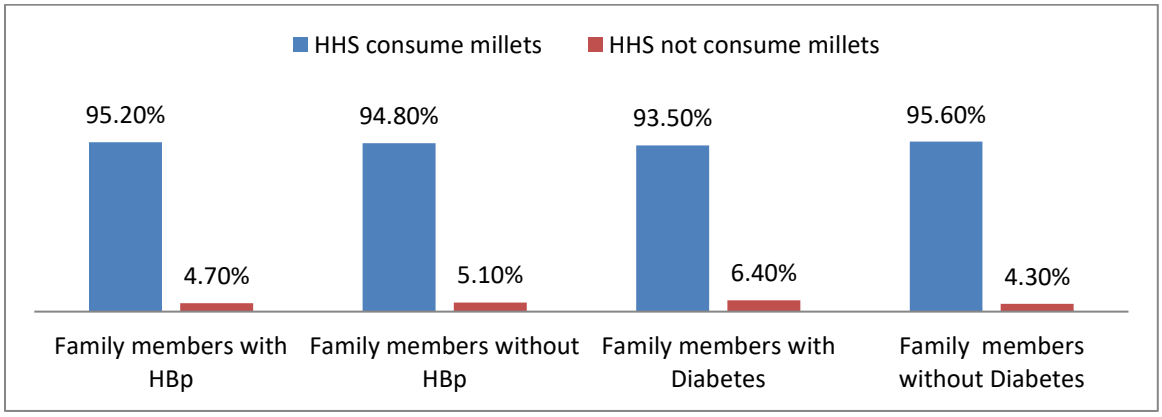


Figure 4.33: Millet consumption by respondents considering their age, education and occupation status.

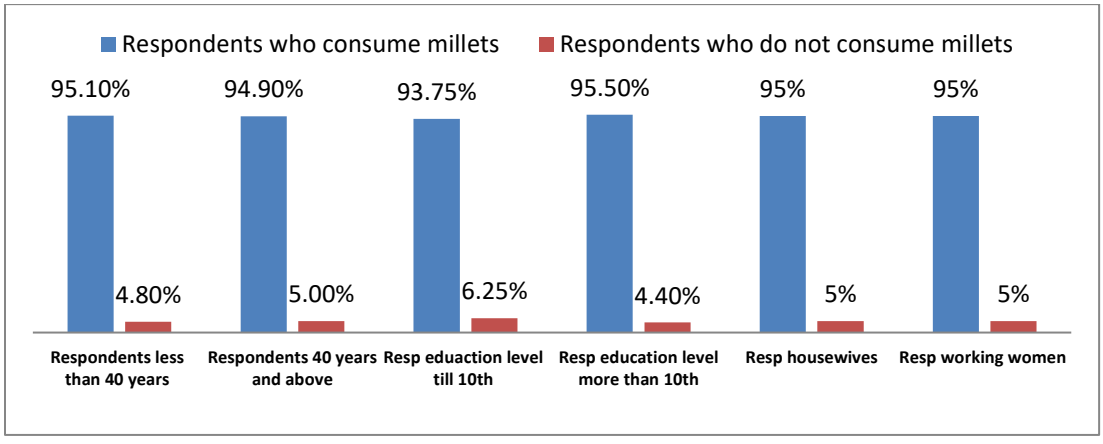


Figure 4.34: Association between occupation of head of the household and millets consumed in households (HDD score)

Crosstab

			occupation of head of the household					Total
			service	business	gov employee	other	6	
millets consumed (HDD)	yes	Count	14	2	1	1	0	18
		Expected Count	13.3	3.4	.4	.7	.2	18.0
	no	Count	60	17	1	3	1	82
		Expected Count	60.7	15.6	1.6	3.3	.8	82.0
Total		Count	74	19	2	4	1	100
		Expected Count	74.0	19.0	2.0	4.0	1.0	100.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	2.501[a]	4	.644
Likelihood Ratio	2.434	4	.657
Linear-by-Linear Association	.000	1	.983
N of Valid Cases	100		

a. 7 cells (70.0%) have expected count less than 5. The minimum expected count is .18.

Figure 4.35: Association between ethnicity and millets consumed in households (HDD score)

Crosstab

			ethnicity					Total
			gujarati	marathi	kathiyawadi	others	6	
millets consumed (HDD)	yes	Count	12	1	1	4	0	18
		Expected Count	9.4	1.3	.5	6.7	.2	18.0
	no	Count	40	6	2	33	1	82
		Expected Count	42.6	5.7	2.5	30.3	.8	82.0
Total		Count	52	7	3	37	1	100
		Expected Count	52.0	7.0	3.0	37.0	1.0	100.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	2.966[a]	4	.563
Likelihood Ratio	3.189	4	.527
Linear-by-Linear Association	2.152	1	.142
N of Valid Cases	100		

a. 5 cells (50.0%) have expected count less than 5. The minimum expected count is .18.

Figure 4.36: Association between type of family and millets consumed in households (HDD score)

Crosstab

			type of family			Total
			nuclear	joint	extended nuclear	
millets consumed (HDD)	yes	Count	11	4	3	18
		Expected Count	12.6	1.8	3.6	18.0
	no	Count	59	6	17	82
		Expected Count	57.4	8.2	16.4	82.0
Total		Count	70	10	20	100
		Expected Count	70.0	10.0	20.0	100.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	3.649[a]	2	.161
Likelihood Ratio	3.024	2	.220
Linear-by-Linear Association	.103	1	.748
N of Valid Cases	100		

a. 2 cells (33.3%) have expected count less than 5. The minimum expected count is 1.80.

Figure 4.37: Association between total members in family and millets consumed in households (HDD score)

Crosstab

			total members in family									Total
			1	2	3	4	5	6	7	8	9	
millets consumed (HDD)	yes	Count	0	2	6	4	3	2	0	1	0	18
		Expected Count	.2	1.6	4.9	6.1	2.9	1.4	.4	.2	.4	18.0
	no	Count	1	7	21	30	13	6	2	0	2	82
		Expected Count	.8	7.4	22.1	27.9	13.1	6.6	1.6	.8	1.6	82.0
Total		Count	1	9	27	34	16	8	2	1	2	100
		Expected Count	1.0	9.0	27.0	34.0	16.0	8.0	2.0	1.0	2.0	100.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	7.255[a]	8	.509
Likelihood Ratio	7.070	8	.529
Linear-by-Linear Association	.003	1	.959
N of Valid Cases	100		

a. 12 cells (66.7%) have expected count less than 5. The minimum expected count is .18.

Figure 4.38: Association between medical history of family members in households and millets consumed in households (HDD score)

Crosstab

			medical history in households		
			yes	no	Total
millets consumed (HDD)	yes	Count	15	3	18
		Expected Count	11.2	6.8	18.0
	no	Count	47	35	82
		Expected Count	50.8	31.2	82.0
Total		Count	62	38	100
		Expected Count	62.0	38.0	100.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	4.240[a]	1	.039		
Continuity Correction[b]	3.208	1	.073		
Likelihood Ratio	4.679	1	.031		
Fisher's Exact Test				.059	.033
Linear-by-Linear Association	4.198	1	.040		
N of Valid Cases	100				

a. 0 cells (.0%) have expected count less than 5. The minimum expected count is 6.84.

b. Computed only for a 2x2 table

Figure 4.39: Association between awareness about millets in households and millets consumed in households (HDD score)

Crosstab

			awarness about millets		
			yes	no	Total
millets consumed (HDD)	yes	Count	18	0	18
		Expected Count	17.8	.2	18.0
	no	Count	81	1	82
		Expected Count	81.2	.8	82.0
Total		Count	99	1	100
		Expected Count	99.0	1.0	100.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.222[a]	1	.638		
Continuity Correction[b]	.000	1	1.000		
Likelihood Ratio	.399	1	.528		
Fisher's Exact Test				1.000	.820
Linear-by-Linear Association	.220	1	.639		
N of Valid Cases	100				

a. 2 cells (50.0%) have expected count less than 5. The minimum expected count is .18.

b. Computed only for a 2x2 table

Figure 4.40: Association between awareness about benefits of millet consumption in households and millets consumed in households (HDD score)

Crosstab

			aware about benefits of millet consumption		
			yes	no	Total
millets consumed (HDD)	yes	Count	15	3	18
		Expected Count	15.7	2.3	18.0
	no	Count	72	10	82
		Expected Count	71.3	10.7	82.0
Total		Count	87	13	100
		Expected Count	87.0	13.0	100.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)	Exact Sig. (2-sided)	Exact Sig. (1-sided)
Pearson Chi-Square	.261[a]	1	.609		
Continuity Correction[b]	.015	1	.901		
Likelihood Ratio	.247	1	.619		
Fisher's Exact Test				.699	.426
Linear-by-Linear Association	.258	1	.611		
N of Valid Cases	100				

a. 1 cells (25.0%) have expected count less than 5. The minimum expected count is 2.34.

b. Computed only for a 2x2 table

Figure 4.41: Association between type of diet and millets consumed in households (HDD score)

Crosstab

			type of diet			
			veg	nonveg	ovoveg	Total
millets consumed (HDD)	yes	Count	11	5	2	18
		Expected Count	10.6	5.2	2.2	18.0
	no	Count	48	24	10	82
		Expected Count	48.4	23.8	9.8	82.0
Total		Count	59	29	12	100
		Expected Count	59.0	29.0	12.0	100.0

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	.042[a]	2	.979
Likelihood Ratio	.043	2	.979
Linear-by-Linear Association	.040	1	.842
N of Valid Cases	100		

a. 1 cells (16.7%) have expected count less than 5. The minimum expected count is 2.16.

Figure 4.42: Association between income and millets consumed in households (HDD score)

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	43.971[a]	31	.061
Likelihood Ratio	43.532	31	.067
Linear-by-Linear Association	1.563	1	.211
N of Valid Cases	100		

a. 59 cells (92.2%) have expected count less than 5. The minimum expected count is .18.

Figure 4.43: Association between age of respondents and millets consumed in households (HDD score)

Chi-Square Tests

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	31.415[a]	31	.445
Likelihood Ratio	33.502	31	.347
Linear-by-Linear Association	.002	1	.963
N of Valid Cases	100		

a. 60 cells (93.8%) have expected count less than 5. The minimum expected count is .18.

Highlights

- In the study 98 percent of the respondents were Hindus and approximately 50% of them were Gujarati.
- 62 percent of the respondents had family members who had co-morbidities such as obesity, diabetes, heart related problems etc.
- 87 percent of the respondents were aware about the benefits of millet consumption as most of them considered millets to provide health benefits, increase fiber in the diet, lowers blood sugar and lowers lipid profile.
- 84 percent of the respondents purchased millets from the market whereas 11 percent of the respondents had their own farm produced millets.
- 75.4 percent of the respondents in the households preferred consuming moriyo during fasting.
- 75 percent of the respondents consider that millets are not expensivewhen compared with cereals like wheat and rice.
- Only 30 percent of the respondents consumed bajra once a week whereas only 23 percent of them consumed jowar once a month.
- 100 percent consumption of food groups such as cereals, milk and milk products, oil/fats and sugar/honey and consumption of roots and tubers was 82 percent, vegetables was 99 percent, pulses/ legumes/ nuts was 92 percent and fruits was 39 percent was observed using HDD score.

Phase 3: Recipe Development from selected millets for prevention of NCDs

As in the study it was observed that majority of the households were only aware about bajra and jowar consumption and incorporated these millets in their daily diet. A need was felt to increase awareness about other millets and ways to incorporate them in daily diets of the population. Thus in phase 3, total six millets were selected that is bajra, jowar, ragi, kodari, amaranth and samo for the development of recipes. These millets were selected on basis of it availability in the market and its awareness and consumption in Vadodara city. Five recipes from each were planned for one serving and nutritional values were also calculated. (Table 4.5, Table 4.6, Table 4.7, Table 4.8, Table 4.9, Table 4.10) The average content of energy in recipes is 232.66 ± 56.51kcal. The average protein content of the recipes is 6.55 ± 2.21g. The average content of carbohydrates in the recipes is 32.32 ±10.31g. The average content of fats in the recipes is 7.72 ± 2.60. The average content of dietary fiber, calcium and iron are 5.20 ± 1.78 g, 91.10± 75.61mg and 2.32 ± 0.90 mg respectively.

The planning and development of recipes was done considering the dietary guidelines of non communicable diseases.

Table 4.5: Bajra recipes and nutritional value

Recipe Name	Energy (kcal)	Carbohydrates (g)	Protein (g)	Fat (g)	Calcium (mg)	Iron (mg)	Fiber (g)
Bajra Muthiya	266	39.2	7.3	8	64.3	3.7	8.5
Bajra Appam	291	28.7	7.2	8.4	81.9	2.7	6.7
Bajra Ladoo	236	30.5	5.1	10.1	47	2.6	5.1
Bajra Cheela	197	25.8	6	7.3	33.6	2.8	8.9
Bajra Pizza	287	38	9.4	9.9	123.6	2.9	7.3

Table 4.6: Jowar recipes and nutritional values

Recipe Name	Energy (kcal)	Carbohydrates (g)	Protein (g)	Fat (g)	Calcium (mg)	Iron (mg)	Fiber (g)
Jowar dal	237	35.4	9.2	5.7	24.5	2	5.2
Jowar khicdi	236	35.3	9.1	5.8	24	2	5.9
Jowar soup	114	13	2.2	5.4	25.3	0.7	3.7
Jowar chaat	149	24.4	5.3	2.5	50.6	2.5	6.2
Jowar pancake	195	31.5	3.6	5.5	11.2	1.2	4.1

Table 4.7: Ragi recipes and nutritional values

Recipe Name	Energy (kcal)	Carbohydrates (g)	Protein (g)	Fat (g)	Calcium (mg)	Iron (mg)	Fiber (g)
Ragi idli with chutney	327	45	7.8	12	148.4	2.1	8
Ragi paratha	322	51.9	7.6	11.7	266	3.3	1.7
Ragi energy bar	185	25.1	2.4	8.1	79.2	1.4	3.7
Ragi kanji/savoury soup	148	12	3.5	4.3	193.2	1.4	2.4
Ragi thalipeeth	295	41	7.9	10.6	184.8	3	7.3

Table 4.8: Kodari recipes and nutritional values

Recipe Name	Energy (kcal)	Carbohydrates (g)	Protein (g)	Fat (g)	Calcium (mg)	Iron (mg)	Fiber (g)
Kodari vegetable patty	191	26.2	6.2	6.1	33.2	1.6	5.2
Vegetable kodari pulao	228	22.8	5.3	5.8	34.5	1.8	6.5
Sweet potato kodari kheer	267	39.4	7.2	8.3	213	1	4.7
Kodari mongdal dosa	170	28.5	7	7.1	55.6	1.2	3.3
Kodari in white sauce	243	23.9	7.6	12.1	196.4	0.8	3.4

Table 4.9: Rajgira recipes and nutritional values

Recipe Name	Energy (kcal)	Carbohydrates (g)	Protein (g)	Fat (g)	Calcium (mg)	Iron (mg)	Fiber (g)
Rajgira upma	176	20.9	5.2	6.6	56.9	2.5	3.5
Rajgira handavo	349	58.4	12.1	10.3	172.1	4.1	6.7
Rajgira paratha	267	32.7	7.2	11.5	128.1	4.1	5.6
Rajgira dhokla	231	39.1	7.7	4.3	55.6	2.9	3.8
Rajgira sheera	205	23	4.6	10.1	80.3	2.8	3

Table 4.10: Samo recipes and nutritional values

Recipe Name	Energy (kcal)	Carbohydrates (g)	Protein (g)	Fat (g)	Calcium (mg)	Iron (mg)	Fiber (g)
Samo vadi	208	31	5.4	6.3	36.3	2.5	5.4
Samo masala khicdi	217	32.4	7.6	5.8	23.4	2.2	5.8
Samo uttapa	252	42.6	6	5.8	22.6	2.3	5.3
Samo thepla	206	32.7	4.4	6	53.2	3.1	5.6
Samo halwa	285	37.1	9.1	11.2	256	2.2	3.9

DISCUSSION

Millets are small cereal food grains which are traditionally consumed in India since history. In the present study, from the secondary data source we have tried to gather information on production and consumption pattern of millets in India and Gujarat. According to latest report year 2019-20 shows the decreasing trend of millet production in India and Gujarat.

Niyogi, 2020, reported that in the past six decades, India has witnessed a decrease in the area under millets, but the productivity has increased due to adoption of high- yielding varieties and improved production technologies. The main reasons behind the decline of millet area and production are low remuneration, lack of input subsidies and price incentives, subsidized supply of fine cereals through the public distribution system (PDS) and change in consumer preference.

According to a study by Anbukkani, 2017 it was observed that production of minor millets and finger millet has decreased over the last five decades (1955-56 to 2013-14). It was also observed that the production of minor millet recorded four fold decreases whereas finger millet did not record as much decrease due to double yield almost in this period i.e. from 800kg/ha to 1661 kg/ha in 2013-14. Highest production of small millets was observed in Uttarakhand followed by Tamil Nadu and Gujarat. The consumption pattern of small millets and finger millet in India and rural areas was highest in Assam and Bihar. Hence promotion of small millet consumption should be done using extensive activities.

According to a study by Gowri and Shivakumar, 2020 it was reported that the growth rate of millet area and production had declined at the rate of 16.31% and 13.58% respectively from year 1950-51 to 2018-19. Hence the scenario of millets in India showed a decreasing trend.

According to agricultural statistics report, 2019-20 it was observed that production of millets such as jowar, bajra and other nutri-cereals showed a decreasing trend in both India and Gujarat.

According to C Golpalan's review and comments on restoring millets and pulses to their rightful place in Indian diets, decline in per capita availability and consumption of millets and pulses was observed since 1960 (Green revolution). 25.3 percent decline of coarse cereals (pearl millet, sorghum, maize, finger millet, barely and small millets) in cultivation area and production of millets showed a flat trend over the decades.

Overall millet production and consumption in India is actively recommended and promoted considering the health benefits and potential of millets in providing national food security requirements, maintaining malnutrition burden and providing nutritional health benefits in preventing many chronic diseases. The Indian government had also declared the year 2018 as "The Year of Millets", and many promotional events were and are conducted to increase the awareness, production and consumption of millets in India. Apart from these many national policies and non-government organizations are working on providing high yielding seeds and educational knowledge and required technologies to the farmers and public to promote millets in India. The year 2023, is declared as "International Year of Millet" by Food Agricultural Organization (FAO). Hence all the awareness and promotions of millet show the importance of millet consumption.

The consumption pattern of millets in urban households of Vadodara was also studied, in spite of awareness about millets and their health benefits at household level. The consumption of millets was negligible on daily basis. There was association seen between prevalence of co-morbidities in the households and consumption of millets. It was also found that majority of the households consumed bajra and jowar compared to other available millets in Vadodara.

According to Narasinga Rao, overview on millets in Indian diets concluded that the shift of millet consumption to cereals (rice and wheat) consumption was observed because of readily availability of wheat and rice through PDS system at subsidized cost to the poor.

Umanath et al, 2018 reported that jowar was consumed more overall India by quantity and value whereas bajra was second most predominantly consumed millet in India. It was assumed that as income increases the consumption of millets would decrease.

Acharya N.G, 2018 reported that 70% of respondents observed positive relation between better health and millet consumption. Though 92% of the respondents were aware about benefits of millets still didn't consume millets due to variable factors. It was also observed that the respondents consumed millets on either everyday or alternate day basis.

In the present study to popularize the recipes from various millets, a recipe booklet was also developed. It was considering the dietary guidelines of non communicable diseases in the study. Total 30 recipes were standardized from 6 different millets.

The average nutritive value of standardized recipes is presented below:

Nutrient	Values
Energy	232.66 ± 56.51kcal
Protein	6.55 ± 2.21g
Carbohydrates	32.32 ±10.31g
Fat	7.72 ± 2.60g
Dietary fiber	5.20 ± 1.78 g
Calcium	91.10± 75.61mg
Iron	2.32 ± 0.90 mg

During literature search various recipe booklets on millets were reviewed. Our recipes booklet provides following instructions:

- Raw and cooked weight and volume of recipe
- Nutritive value of one serving (energy, protein, fat, calcium, iron and fiber)
- Cost per serving
- Cooking method
- Benefits of consuming

MILLET INCORPORATED RECIPES FOR NCD PREVENTION

Developed by: Divya Negandhi

Guided by: Dr. Hemangini Gandhi

THE MAHARAJA SAYAJIRAO UNIVERSITY OF BARODA
सत्यं शिवं सुन्दरम्
Estd. 1949

DEPARTMENT OF FOODS AND NUTRITION

FACULTY OF FAMILY AND COMMUNITY SCIENCES

THE MAHARAJA SAYAJIRAO UNIVERSITY OF BARODA

VADODARA-390002, GUJARAT

JUNE, 2021

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Preface

Millets are traditionally consumed small cereals which are highly nutritious and widely known and grown in Indian setup. Thus to increase awareness and knowledge about various health benefits of millets and different ways to incorporate them in our daily life the booklet is a helping aid. In the current scenario with national schemes and international promotional events are a beneficial step towards better utilization of millets and increasing its consumption by the people. The booklet also shares the same aim of promoting and increasing awareness about millets.

Thus an attempt is made by developing millet based recipes which will help in both increasing awareness about millets among the people and help in overcoming the burden of Non-communicable diseases.

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INTRODUCTION

Millets also popularly known as nutri-cereals or coarse cereals, they are nutrient dense group of small-grained cereals which are largely cultivated in developing countries. They are used as both fodder and food grains. They are cultivated in extreme weather conditions and low rainfall and low fertile soil areas, making them contributors to food security in India. In spite of millets cultivation conditions they are high in nutrition and provide many health benefits against many diseases. They are gluten free and rich in minerals and vitamins, consumption of millets helps in decrease in triglycerides, inflammatory markers like C- reactive proteins which help in prevention from cardiovascular disease and its complications. Millets are comparatively rich in dietary fiber then other cereals. This dietary fiber has the ability to provide bulk and have water absorption property. This helps in increasing the transit time of food digestion in the body which helps in reducing the risk of inflammatory bowel disease and other gastro-intestinal problems.

Pearl millet / Bajra

- Pearl millet commonly known as bajra is consumed in Gujarat and other parts of India.
- It is nutritious and easy to digest cereal grain compared to other cereals.
- It is gluten free, considered as ideal choice of cereal for celiac disease and gluten intolerance.
- Bajra's high phosphorus content helps in strengthening of bones.
- Bajra helps to relive constipation as it consists of enough good fat, which is ideal quality for people with high cholesterol.
- Bajra reduces the risk of colon cancer as alkalizes the pH of the stomach, thereby reducing the risk of colon cancer.
- Bajra also provides good amount of dietary fiber and is rich in iron and can help in prevention of anemia in girls.

Nutrients	**Per 100g**
Energy	347 kcal
Carbohydrates	61.78g
Protein	10.96g
Fat	5.43g
Calcium	27.35mg
Iron	6.42mg
Fiber	11.49g

1. Bajra Muthiya

Ingredients

- Bajra flour : 30g
- Wheat flour: 30g
- Salt: 1g
- Carrot: 10g
- Onion: 10g
- Cabbage: 15g
- 1tbsp chopped coriander
- Oil : 5g
- ¼th tsp mustard seeds
- Sesame seeds: 2.5g
- 3-5 curry leaves

Method of cooking

- Mix coarse bajra flour, wheat flour, grated onion, carrot and cabbage. Add salt, ¼ tsp turmeric powder, 1 tsp ginger, garlic and chili paste, ¼ tsp garam masala, ¼ tsp coriander powder and ¼ th tsp cumin powder. Squeeze ¼ lemon, mix well and knead into a soft dough.
- Apply some oil in your hands and divide the dough into two equal portions and shape each portion into a cylindrical roll.
- Steam cook for 20-30 minutes in steamer.
- After a while cut into slices.
- For the seasoning, heat the remaining oil in a deep non-stick pan and add the mustard seeds, curry leaves and sesame seeds and sauté on a medium flame for 30 seconds.
- Add the bajra muthiya pieces and sauté on a medium flame for 4-5 minutes or until they turn light brown in colour and crisp.
- Serve the bajra muthiya garnished with coriander.

Nutrient value per serving

Nutrients	Per 100g
Energy (kcal)	266
Carbohydrate (g)	39.2
Protein (g)	7.3
Fat (g)	8
Calcium (mg)	64.3
Iron (mg)	3.7
Fiber (g)	8.5

Cooked weight: 150 g

Serving size: 1 plate

2. Bajra Appam

Ingredients

- Bajra flour : 30g
- Rice : 20g
- Urad dal: 10g
- Salt: 1g
- Carrot: 10g
- Onion: 15g
- Cabbage: 15g
- Peas: 5g
- Corn: 5g
- Curd: 15g
- 1tbsp chopped coriander
- Oil : 5g
- ¼th tsp mustard seeds
- Sesame seeds: 2.5g

Method of cooking

- In a mixer grind rice and urad dal, in a mixing bowl add bajra flour, rice and urad flour, grated onion, carrot, boiled corn and peas, finely chopped cabbage, curd, salt, 1tsp ginger, garlic and chili paste, ¼ tsp garam masala, ¼ tsp coriander powder and ¼ tsp cumin powder. Squeeze ¼ lemon, mix well into a thick batter.
- In appam pan apply some oil and add sesame and mustard seeds let it splutter and add the batter and let it cook for 5-10 minutes.
- Garnish it with coriander, serve hot with coriander chutney

Nutrient value per serving

Nutrients	Per 100g
Energy (kcal)	291
Carbohydrate (g)	28.7
Protein (g)	7.2
Fat (g)	8.4
Calcium (mg)	81.9
Iron (mg)	2.7
Fiber (g)	6.7

Cooked weight: 77 g

Serving size: 1 plate

3. Bajra Ladoo

Ingredients

- Bajra flour : 30g
- Dates: 10g
- Kishmish: 5g
- Almonds: 5g
- Milk: 15ml
- Ghee: 5g

Method of cooking

- In a kadhai, heat ghee then add bajra flour, dates, kishmish, almonds and roast for 1-2 minutes.
- Once cool transfer it into a mixer and add milk and blend.
- Take small portion of the mix and roll them into ladoos.

Nutrient value per serving

Nutrients	Per 100g
Energy (kcal)	236
Carbohydrate (g)	30.5
Protein (g)	5.1
Fat (g)	10.1
Calcium (mg)	47
Iron (mg)	2.6
Fiber (g)	5.1

Cooked weight: 65 g

Serving size: 2 ladoos

Outcome: 4 ladoos

4. Bajra Cheela

Ingredients

- Bajra flour : 30g
- Beasan: 10g
- Salt 1g
- Onion: 10g
- Capsicum: 10g
- Tomato: 10g
- Spinach: 20g
- 1tbsp chopped coriander
- Oil : 5g

Method of cooking

- Mix bajra flour, besan, finely chopped onion, capsicum, tomato and spinach, add salt, 1 tsp of ginger, garlic and chili paste, ¼ tsp turmeric powder, 1 tsp ginger, garlic and chili paste, ¼ tsp garam masala, ¼ tsp coriander powder and ¼ th tsp cumin powder. Squeeze ¼ lemon, mix well into a thick batter.
- Heat the pan and pour the batter and spread it like a dosa.
- Serve hot with coriander chutney or ketchup.

Nutrient value per serving

Nutrients	Per 100g
Energy (kcal)	197
Carbohydrate (g)	25.8
Protein (g)	6
Fat (g)	7.3
Calcium (mg)	33.6
Iron (mg)	2.8
Fiber (g)	8.9

Cooked weight: 128g

Serving size: 4 cheelas, 1plate

5. Bajra Pizza

Ingredients

- Bajra flour : 30g
- Wheat flour: 20g
- Salt 1g
- Onion: 30g
- Capsicum: 10g
- Tomato: 30g
- Corn: 5g
- Paneer: 20g
- Oil : 5g

Method of cooking

- Mix bajra flour, wheat flour and oil knead into soft dough.
- Roll out into thick chapati and semi roast it.
- Apply pizza sauce and chopped vegetables and season it with pinch of black pepper powder, mixed herbs and chili flakes and grated paneer.
- Bake it for 2-3 minutes at 180 degree Celsius.
- Serve hot.

Nutrient value per serving

Nutrients	Per 100g
Energy (kcal)	287
Carbohydrate (g)	38
Protein (g)	9.4
Fat (g)	9.9
Calcium (mg)	123.6
Iron (mg)	2.9
Fiber (g)	7.3

Cooked weight: 175 g

Serving size: 1plate

Sorghum / Jowar

- Jowar helps in better digestion and digestive health
- Jowar consumption aids in improving heart health
- It is also gluten free, can be consumed by patients with celiac disease
- It provides good amount of energy and other nutrients
- It also helps in promoting bone health and boosts circulation in the body
- It is also known to aid in controlling diabetes.
- It provides good amount of protein and dietary fiber in the diet and is comparatively low in fats.

Nutrients	**Per 100g**
Energy	334 kcal
Carbohydrates	67.68g
Protein	9.97g
Fat	1.73g
Calcium	27.6mg
Iron	3.95mg
Fiber	10.22g

6. Jowar Moong dal

Ingredients

- Jowar whole: 30g
- Moong dal: 25g
- Salt 1g
- Onion: 15g
- Capsicum: 10g
- Tomato: 25g
- 1tbsp chopped coriander
- Ghee : 5g

Method of cooking

- Soak jowar overnight at pressure cook it with moong dal. Blend it once cooled.
- Add ghee in a pan, add mustard seeds, crushed garlic cloves (2-3), slit green chili and chopped ginger, onion and tomatoes and sauté it for 30 seconds.
- Add salt, ¼ tsp turmeric powder, ¼ tsp asafetida (hing), ¼ lemon juice and ¼ tsp chili powder.
- Add the blended paste of jowar and moong dal and boil it for 5-8 minutes.
- Garnish it with coriander and serve hot with sabji and roti.

Nutrient value per serving

Nutrients	Per 100g
Energy (kcal)	237
Carbohydrate (g)	35.4
Protein (g)	9.2
Fat (g)	5.7
Calcium (mg)	24.5
Iron (mg)	2
Fiber (g)	5.2

Cooked weight: 150g

Serving size: 1 bowl

7. Jowar Moong dal Khicdi

Ingredients

- Jowar whole : 30g
- Moong dal: 25g
- Salt 1g
- Onion: 15g
- Tomato: 20g
- 1tbsp chopped coriander
- Oil : 5g

Method of cooking

- Soak jowar overnight. In pressure cooker heat oil, add pinch of asafetida (hing), 1 tsp of ginger, garlic, chili paste, chopped onion and tomatoes and sauté it for 30 seconds.
- Add ¼ tsp turmeric powder, ¼ tsp garam masala, ¼ tsp coriander powder, salt, chopped coriander, add soaked jowar and moong dal and pressure cook it.
- After 5-6 whistle squeeze ¼ lemon and serve hot.

Nutrient value per serving

Nutrients	Per 100g
Energy (kcal)	236
Carbohydrate (g)	35.3
Protein (g)	9.1
Fat (g)	5.8
Calcium (mg)	24
Iron (mg)	2
Fiber (g)	5.9

Cooked weight: 150g

Serving size: 1 plate

8. Jowar Vegetable Soup

Ingredients

- Jowar whole : 15g
- Tomato: 50g
- Carrot: 20g
- Bottle gourd: 10g
- Cabbage: 15g
- Salt 1g
- Oil : 5g
- 3-4 curry leaves

Method of cooking

- Soak jowar overnight and pressure cook it.
- In a blender add chopped vegetables and blend it and add black pepper powder and salt. Cook the puree till it boils.
- Add cooked jowar to the mix. For seasoning, heat oil, add ¼ tsp of cumin and 3-4 curry leaves and add it to soup.
- Serve it hot.

Nutrient value per serving

Nutrients	Per 100g
Energy (kcal)	114
Carbohydrate (g)	13
Protein (g)	2.2
Fat (g)	5.4
Calcium (mg)	25.3
Iron (mg)	0.7
Fiber (g)	3.7

Cooked weight: 150g

Serving size: 1 bowl

9. Jowar Vegetable Chaat

Ingredients

- Jowar whole : 30g
- Carrot: 15g
- Spring onion: 10g
- Capsicum: 15g
- Pomegranate: 15g
- Coriander: 20g
- Peanuts: 5g
- Salt: 1g

Method of cooking

- Soak jowar overnight and pressure cook it. Mix cooked jowar chopped vegetables and pomegranate, add salt, ¼ lemon, black pepper powder, and coriander chutney. Mix it well.
- For coriander chutney, in a mixer add peanuts, chili, ginger and chopped coriander and ¼ lemon, salt.
- Serve chaat in a bowl.

Nutrient value per serving

Nutrients	Per 100g
Energy (kcal)	149
Carbohydrate (g)	24.4
Protein (g)	5.3
Fat (g)	2.5
Calcium (mg)	50.6
Iron (mg)	2.5
Fiber (g)	6.2

Cooked weight: 118.5g

Serving size: 1 bowl

10. Jowar Pancake

Ingredients

- Jowar flour: 15g
- Wheat flour: 15g
- Banana: 50g
- Ghee: 5g

Method of cooking

- Mix jowar flour and wheat flour with mashed banana and make a thick batter.
- Heat a pan and pour the batter and spread in a circular motion, add ghee.
- Serve hot.

Nutrient value per serving

Nutrients	Per 100g
Energy (kcal)	195
Carbohydrate (g)	31.5
Protein (g)	3.6
Fat (g)	5.5
Calcium (mg)	11.2
Iron (mg)	1.2
Fiber (g)	4.1

Cooked weight: 98.6g

Serving size: 1plate (2 pieces)

Finger millet/ Ragi

- Ragi consumption helps in reducing cholesterol and improves digestion.
- It helps in controlling diabetes and improves bone health.
- It is good source of protein and amino acids and helps to treat anemia.
- It works as a natural relaxant and reverts skin ageing.
- During pregnancy it helps in reducing the risk of gestational diabetes and increases lactation.
- Ragi is a rich source of calcium and fiber.

Nutrients	**Per 100g**
Energy	320 kcal
Carbohydrates	66.82g
Protein	7.16g
Fat	1.92g
Calcium	364mg
Iron	4.62mg
Fiber	11.18g

11. Ragi Idli with Chutney

Ingredients

- Ragi flour : 30g
- Rice : 20g
- Urad dal: 10g
- Curd: 15g
- Onion: 10g
- Capsicum: 10g
- Carrot: 10g
- Fresh coconut: 20g
- Urad dal: 2.5g
- Salt 1g
- Oil : 2.5g

Method of cooking

- Grind rice and urad dal. Mix ragi, rice and urad flour with curd and let it rest for 30 minutes.
- Add finely chopped vegetables to the batter and salt. Apply some oil on the idli molds and pour the batter and let it steam cook for 5-7 minutes.
- For coconut chutney, in mixer grind fresh coconut with green chili and curry leaves. Season it with urad dal and pinch of mustard seeds.
- Serve the idlis hot with fresh coconut chutney.

Nutrient value per serving

Nutrients	Per 100g
Energy (kcal)	327
Carbohydrate (g)	45
Protein (g)	7.8
Fat (g)	12
Calcium (mg)	148.4
Iron (mg)	2.1
Fiber (g)	8

Cooked weight: 136 g

Serving size: 1plate

12. Ragi Vegetable Paratha

Ingredients

- Ragi flour : 30g
- Wheat flour: 30g
- Peas:2.5g
- Onion: 10g
- Corn: 2.5g
- Carrot: 10g
- Cauliflower: 10g
- Sesame seeds: 5g
- 1 tbsp of coriander
- Curd: 30g
- Salt: 1g
- Oil :7.5g

Method of cooking

- Blanch all vegetables except onion and mash them. Mix ragi flour, wheat flour, add finely chopped onions, mashed vegetables, 1 tsp of ginger, garlic, chili paste, sesame seeds, pinch of black pepper, ¼ tsp turmeric powder, ¼ tsp of garam masala, ¼ lemon, salt, coriander and knead soft dough.
- Divide the dough into equal sized balls and roll the balls into parathas.
- Heat a tava until hot and transfer a paratha to tava and smear it with oil.
- Serve it with curd or chutney.

Nutrient value per serving

Nutrients	Per 100g
Energy (kcal)	322
Carbohydrate (g)	51.9
Protein (g)	7.6
Fat (g)	11.7
Calcium (mg)	266
Iron (mg)	3.3
Fiber (g)	1.7

Cooked weight: 103.7g

Serving size: 1plate

13. Ragi Energy Bar

Ingredients

- Ragi flour : 15g
- Dates: 15g
- Almonds: 5g
- Raisins: 5g
- Ghee: 5g

Method of cooking

- In a kadhai, heat ghee and add ragi flour, raisins, almonds and dates and roast it for 1-2 minutes.
- Once cooled grind it in a mixer.
- Shape it as a bar and serve it.

Nutrient value per serving

Nutrients	Per 100g
Energy (kcal)	185
Carbohydrate (g)	25.1
Protein (g)	2.4
Fat (g)	8.1
Calcium (mg)	79.2
Iron (mg)	1.4
Fiber (g)	3.7

Cooked weight: 45g

Serving size: 1-2 piece

14. Ragi Kanji/ Savory Soup

Ingredients

- Ragi flour: 15g
- Curd: 50g
- Sesame seeds: 5g
- 1 tbsp chopped coriander
- Oil: 5g

Method of cooking

- Mix ragi flour with water and make a thick paste.
- In a pan heat ½ cup of water, and once water starts boiling add the ragi paste and mix till thick and glossy mixture.
- Once cooled add curd and mix it as a soup consistency. Add sesame seeds and chopped coriander for refreshing taste.

Nutrient value per serving

Nutrients	Per 100g
Energy (kcal)	148
Carbohydrate (g)	12
Protein (g)	3.5
Fat (g)	4.3
Calcium (mg)	193.2
Iron (mg)	1.4
Fiber (g)	2.4

Cooked weight: 155 g

Serving size: 1 bowl

15. Ragi Thalipeeth

Ingredients

- Ragi flour : 30g
- Beasan: 5g
- Wheat flour: 20g
- Rice flour: 5g
- Groundnut roasted: 5g
- Sesame seed:5g
- Salt 1g
- 1tbsp chopped coriander
- Oil : 5g

Method of cooking

- Mix ragi, wheat, rice flour and beasan, add groundnuts, sesame seeds and chopped coriander and add ¼ tsp of turmeric powder, 1/4th tsp of chili powder, ¼ tsp of garam masala, ¼ tsp of coriander and cumin powder, and salt, knead into soft doug .
- Make equal sized balls from the dough and roll it out into thick parathas.
- Heat a tava until hot and transfer the paratha and smear it with oil.
- Serve with curd or chutney.

Nutrient value per serving

Nutrients	Per 100g
Energy (kcal)	295
Carbohydrate (g)	41
Protein (g)	7.9
Fat (g)	10.6
Calcium (mg)	184.8
Iron (mg)	3
Fiber (g)	7.3

Cooked weight: 91.4g

Serving size: 1 plate

Kodo millet/ Kodari

- Kodo millet commonly known as kodari helps in controlling diabetes by controlling obesity and blood sugar.
- It is a good source of magnesium which helps in maintain heart health.
- It consists of nutrients whch help in reducing cholesterol.
- It is a rich source of protein and has high whole grain fiber content.
- It is easy to cook and can be replaced with rice in the diet.

Nutrients	**Per 100g**
Energy	331kcal
Carbohydrates	66.19g
Protein	8.92g
Fat	2.55g
Calcium	15.27mg
Iron	2.34mg
Fiber	6.39g

16. Vegetable Kodari Patty

Ingredients

- Kodari: 25g
- Spring onion: 10g
- Corn: 10g
- Peas: 10g
- French beans: 10g
- Carrot: 10g
- Capsicum: 10g
- Beasan: 5g
- Fresh coriander: 5g
- Salt: 1g
- Oil: 5g

Method of cooking

- Pressure cook kodari and mix it with vegetables and beasan. Add ¼ tsp of turmeric powder, ¼ tsp of chili powder, ¼ tsp of garam masala, salt, ¼ lemon and chopped coriander and mix it well.
- Apply some oil on hands and roll the mix into patty.
- In a pan place the patty and grease it with oil.
- Serve it hot with chutney or ketchup.

Nutrient value per serving

Nutrients	Per 100g
Energy (kcal)	191
Carbohydrate (g)	26.2
Protein (g)	6.2
Fat (g)	6.1
Calcium (mg)	33.2
Iron (mg)	1.6
Fiber (g)	5.2

Cooked weight: 165g

Serving size: 4 pieces

17. Vegetable Kodari Pulao

Ingredients

- Kodari: 25g
- Spring onion: 25g
- Capsicum:30g
- Peas: 30g
- Carrot:25g
- 1tbsp chopped coriander
- Salt: 1g
- Oil : 5g

Method of cooking

- In Pressure cook and oil, asafetida (hing), cumin seeds, chopped vegetables, 1 tsp ginger, garlic paste and slit green chili and sauté it for 30 seconds.
- Add ¼ tsp turmeric powder, ¼ tsp garam masala, ¼ lemon, salt and soaked kodari, mix it well and let it whistle (3-5).
- Garnish it with coriander and serve it with raita.

Nutrient value per serving

Nutrients	Per 100g
Energy (kcal)	228
Carbohydrate (g)	22.8
Protein (g)	5.3
Fat (g)	5.8
Calcium (mg)	34.5
Iron (mg)	1.8
Fiber (g)	6.5

Cooked weight: 214.6g

Serving size: 1 plate

18. Sweet Potato Kodari Kheer

Ingredients

- Kodari: 10g
- Sweet potato: 100g
- Milk: 150ml
- Almonds: 2g
- Raisins: 2g

Method of cooking

- In a kadhai add milk and let it boil for 2-3 minutes.
- Add pressure cooked and grated sweet potato and kodari to the milk and let it boil for 2-3 minutes.
- Add raisins and almonds and let it simmer for 1-2 minutes.
- Garnish it with chopped almonds and serve it hot.

Nutrient value per serving

Nutrients	Per 100g
Energy (kcal)	267
Carbohydrate (g)	39.4
Protein (g)	7.2
Fat (g)	8.3
Calcium (mg)	213
Iron (mg)	1
Fiber (g)	4.7

Cooked weight: 185.5g

Serving size: 1 bowl

19. Kodari Moong dal Dosa

Ingredients

- Kodari: 30g
- Moong dal: 15g
- Curd:30g
- Salt: 1g
- Oil : 5g

Method of cooking

- Soak kodari and moong dal for 1-2 hours before preparation.
- In a mixer add green chili, ginger, cumin and soaked kodari, moong dal and curd and grind it into a thick batter.
- Heat a pan and spread it like dosa and grease it with oil.
- Serve hot with coconut chutney or coriander chutney.

Nutrient value per serving

Nutrients	Per 100g
Energy (kcal)	170
Carbohydrate (g)	28.5
Protein (g)	7
Fat (g)	7.1
Calcium (mg)	55.6
Iron (mg)	1.2
Fiber (g)	3.3

Cooked weight: 162.7g

Serving size: 1 plate

20. Kodari in White Sauce

Ingredients

- Kodari: 15g
- Carrot: 15g
- Peas: 10g
- Corn: 10g
- Onion: 25g
- Capsicum:15g
- Milk: 150ml
- Wheat flour: 1.25g
- Salt: 1g
- Oil : 5g

Method of cooking

- Soak kodari before cooking. Blanch all the vegetables except onion and capsicum.
- In a pan add oil and sauté onion and capsicum with pinch of mixed herbs and chili flakes and keep it aside.
- In the same pan add milk, once starts boiling add wheat flour and keep it stirring, add salt, kodari and all the vegetables and let it cook for 5-8 minutes.
- Serve it hot.

Nutrient value per serving

Nutrients	Per 100g
Energy (kcal)	243
Carbohydrate (g)	23.9
Protein (g)	7.6
Fat (g)	12.1
Calcium (mg)	196.4
Iron (mg)	0.8
Fiber (g)	3.4

Cooked weight: 230g

Serving size: 1 bowl

Amaranth/ Rajgira

- Rajgira is rich in protein and easy to digest which helps in digestion and maintaining body muscles.
- It is rich in calcium and iron which help in maintaining bone health and prevention of anemia.
- It helps in improving immunity and heart health.
- Rajgira consists of folate which helps during pregnancy and rajgira oil aids in improving hair and skin health.
- It is gluten free and helps in preventing inflammation.

Nutrients	**Per 100g**
Energy	355kcal
Carbohydrates	61.46g
Protein	13.27g
Fat	5.56g
Calcium	162mg
Iron	8.02mg
Fiber	7.47g

21. Rajgira Upma

Ingredients

- Rajgira flour:30g
- Capsicum:15g
- Onion:15g
- Urad dal: 2.5g
- Peas: 5g
- Corn: 5g
- Salt:1g
- Oil : 5g

Method of cooking

- Heat a pan and dry roast rajgira flour for 1-2 minutes and keep it aside.
- In the same pan heat some oil and add urad dal, curry leaves, chopped vegetables and green chili and ginger and sauté it for 30-40 seconds.
- Add roasted flour and 1 cup of water and let it cook for 2- 5 minutes.
- Serve it hot.

Nutrient value per serving

Nutrients	Per 100g
Energy (kcal)	176
Carbohydrate (g)	20.9
Protein (g)	5.2
Fat (g)	6.6
Calcium (mg)	56.9
Iron (mg)	2.5
Fiber (g)	3.5

Cooked weight: 85.6g

Serving size: 1 bowl

22. Rajgira Handavo

Ingredients

- Rajgira: 25g
- Rice: 30g
- Urad dal: 10g
- Chana dal: 10g
- Bottle gourd: 25g
- Curd:30g
- Sesame seeds:5g
- Salt: 1g
- Coriander:5g
- Oil : 5g

Method of cooking

- In a mixer grind rajgira, rice, urad and chana dal into one coarse flour and mix it with curd and leave it to ferment overnight.
- Add salt. Grated bottle gourd, chopped coriander and 1 tsp of ginger, garlic, chili paste and ¼ tsp turmeric powder and mix it well.
- Heat a pan and for seasoning add mustard and sesame seeds with curry leaves. Once they splutter, pour the batter and let it cook on a slow flame for about 5- 10 minutes.
- Serve hot with chutney.

Nutrient value per serving

Nutrients	Per 100g
Energy (kcal)	349
Carbohydrate (g)	58.4
Protein (g)	12.1
Fat (g)	10.3
Calcium (mg)	172.1
Iron (mg)	4.1
Fiber (g)	6.7

Cooked weight: 185.5g

Serving size: 1plate

23. Rajgira Koki Paratha

Ingredients

- Rajgira flour : 30g
- Wheat flour: 20g
- Salt 1g
- Onion: 10g
- Coriander: 5g
- Sesame seeds: 5g
- Oil : 7.5g

Method of cooking

- Mix rajgira flour, wheat flour, chopped onion and coriander, sesame seeds, ¼ tsp cumin, ¼ lemon, salt, pinch of black pepper powder, chopped green chili and knead into soft dough.
- Make equal proportions of the dough and roll out as paratha.
- Heat a tava and place the paratha on it and grease it with oil.
- Serve hot with chutney or raita.

Nutrient value per serving

Nutrients	Per 100g
Energy (kcal)	267
Carbohydrate (g)	32.7
Protein (g)	7.2
Fat (g)	11.5
Calcium (mg)	128.1
Iron (mg)	4.1
Fiber (g)	5.6

Cooked weight: 85.2 g

Serving size: 1plate

24. Rajgira Dhokla

Ingredients

- Rajgira flour : 30g
- Rice: 20g
- Urad dal: 10g
- Curd:15g
- Salt 1g
- 1tbsp chopped coriander
- Oil : 2.5g

Method of cooking

- In a mixer grind rice and urad dal into coarse flour and add rajgira flour with curd to the mix and make a thick batter, leave it overnight to ferment.
- Add salt to the batter and stir it well. Grease a plate with some oil and pour the batter into it, sprinkle pinch of black pepper powder on it and steam it for 5-8 minutes in the steamer.
- Once cooled, cut into pieces and garnish it with coriander.
- Serve hot with coriander chutney

Nutrient value per serving

Nutrients	Per 100g
Energy (kcal)	240
Carbohydrate (g)	39.5
Protein (g)	8.1
Fat (g)	4.9
Calcium (mg)	77.9
Iron (mg)	2.9
Fiber (g)	3.8

Cooked weight: 128.6g

Serving size: 1plate

25. Rajgira Sheera

Ingredients

- Rajgira flour : 30g
- Milk: 15 ml
- Raisins: 5g
- Almonds:5g
- Ghee : 5g

Method of cooking

- Heat ghee in a pan on medium low heat.
- Once hot add rajgira flour and keep cooking with constant stirring wita a spatula.
- Roast the flour till nutty aroma of the flour and slighltly brown in colour.
- Once roasted add warm milk and crushed raisins to the mixture and mix it well with the spatula.
- Cook it till it gets thick and ghee starts to ooze out from the sides. And turn off the stove.
- Add chopped almonds and pinch of cardamom powder, mix well and serve.

Nutrient value per serving

Nutrients	Per 100g
Energy (kcal)	205
Carbohydrate (g)	23
Protein (g)	4.6
Fat (g)	10.3
Calcium (mg)	80.3
Iron (mg)	2.8
Fiber (g)	3

Cooked weight: 65g

Serving size: 1 katori

Barnyard millet / Samo

- Samo is low in calories and high in protein, which can be easily digested by the body.
- It is a excellent source of dietary fiber and helps in prevention of constipation, bloating and cramping.
- It is gluten free, appropriate for people with gluten insensitivity.
- It provides good source of iron, hence help in prevention of anemia among the vegetarians.

Nutrients	**Per 100g**
Energy	307 kcal
Carbohydrates	65.5g
Protein	6.2g
Fat	2.2g
Calcium	20mg
Iron	5mg
Fiber	9.8g

26. Samo Vadi

Ingredients

- Samo flour : 30g
- Beasan: 10g
- Rava: 5g
- Salt 1g
- Cabbage: 10g
- Coriander: 10g
- Corn: 10g
- Carrot: 20g
- Oil : 5g

Method of cooking

- Mix samo flour, beasan, rava, finely chopped vegetables, add salt, ¼ tsp turmeric powder, ¼ tsp red chili powder, ¼ lemon, ¼ tsp garam masala, ¼ tsp coriander and cumin powder and mix it well.
- Roll out in shape of round small balls and press them into a vadi.
- Heat a pan and place the vadi on it, apply oil and let them cook till little brownish in colour and crisp in texture.
- Serve it hot with coriander chutney.

Nutrient value per serving

Nutrients	Per 100g
Energy (kcal)	208
Carbohydrate (g)	31
Protein (g)	5.4
Fat (g)	7.3
Calcium (mg)	36.3
Iron (mg)	2.5
Fiber (g)	5.4

Cooked weight: 152 g

Serving size: 4 vadi, 1plate

27. Samo Masala Khicdi

Ingredients

- Samo whole: 30g
- Moong dal: 20g
- Salt 1g
- Peas: 10g
- Cauliflower: 10g
- Onion: 10g
- Capsicum: 10g
- 1tbsp chopped coriander
- Oil : 5g

Method of cooking

- Wash and soak samo and moong dal mix aside.
- In a pressure cooker add oil and let it heat, add ¼ tsp of asafetida (hing), 1 tsp of ginger, garlic, chili paste, ¼ tsp mustard seeds, ¼ tsp turmeric powder, ¼ tsp garam masala and chopped vegetables and let it simmer for 1minute.
- Add soaked samo and moong dal mixture and close the lid of the cooker and let it whistle (3-4).
- Once cooled, squeeze ¼ lemon and garnish it with coriander. Mix well and serve hot with curd or kadhi.

Nutrient value per serving

Nutrients	Per 100g
Energy (kcal)	217
Carbohydrate (g)	32.4
Protein (g)	7.6
Fat (g)	5.8
Calcium (mg)	23.4
Iron (mg)	2.2
Fiber (g)	5.8

Cooked weight: 243.4g

Serving size: 1bowl

28. Samo Uttapa

Ingredients

- Samo: 30g
- Rice: 20g
- Urad dal: 10g
- Curd: 15g
- Salt 1g
- Onion: 10g
- Capsicum: 10g
- Tomato: 10g
- 1tbsp chopped coriander
- Oil : 5g

Method of cooking

- Grind samo, rice and urad dal into flour and mix with curd into a thick batter. Leave it over night to ferment.
- Add salt to batter. Heat a dosa pan and pour the batter and spread it like thick dosa.
- Add finely chopped vegetables and grease it with oil. Let it cook for 1-2 minutes.
- Garnish it with coriander and sprinkle some black pepper powder on it.
- Serve it hot with coconut chutney and sambhar.

Nutrient value per serving

Nutrients	Per 100g
Energy (kcal)	261
Carbohydrate (g)	43
Protein (g)	6.4
Fat (g)	6.4
Calcium (mg)	44.9
Iron (mg)	2.3
Fiber (g)	5.3

Cooked weight: 157.8 g

Serving size: 1plate

29. Samo Thepla

Ingredients

- Samo flour : 30g
- Wheat flour: 20g
- Methi leaves: 15g
- Salt 1g
- Oil : 5g

Method of cooking

- Mix samo flour, wheat flour, 1 tsp ginger chili paste, finely chopped methi leaves, salt, ¼ tsp turmeric powder, pinch asafetida (hing) and knead soft dough.
- Make equal balls and roll out as medium thickness chapattis.
- Heat a tava and place the roll outs and let them roast. Apply oil.
- Serve hot with curd or pickle.

Nutrient value per serving

Nutrients	Per 100g
Energy (kcal)	206
Carbohydrate (g)	32.7
Protein (g)	4.4
Fat (g)	6
Calcium (mg)	53.2
Iron (mg)	3.1
Fiber (g)	5.6

Cooked weight: 106.7g

Serving size: 1plate

30. Samo Halwa

Ingredients

- Samo: 30g
- Milk: 200ml
- Almonds: 3g
- Dates: 10g

Method of cooking

- In a pan heat milk till it starts boiling. Add crushed dates paste and soaked samo
- Let it simmer and let it cook till thick in consistency.
- Garnish it with chopped almonds and pinch of cardamom powder mix it well and serve hot.

Nutrient value per serving

Nutrients	Per 100g
Energy (kcal)	285
Carbohydrate (g)	37.1
Protein (g)	9.1
Fat (g)	11.2
Calcium (mg)	256
Iron (mg)	2.2
Fiber (g)	3.9

Cooked weight: 78.3 g

Serving size: 1 bowl

Standard cups and spoons used for measuring the ingredients

DEPARTMENT OF FOODS AND NUTRITION

FACULTY OF FAMILY AND COMMUNITY SCIENCES

THE MAHARAJA SAYAJIRAO UNIVERSITY OF BARODA

VADODARA-390002, GUJARAT

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SUMMARY AND CONCLUSIONS

SUMMARY

Millets are group of small grained cereal food crops which are highly nutritious and are grown under marginal/low fertile soils with very low inputs such as fertilizers and pesticides. These crops largely contribute to food and nutritional security of the country. Most of millet crops are native of India and are popularly known as Nutri-cereals as they provide most of the nutrients required for normal functioning of human body. Millets are rain fed crops and are grown in regions with low rainfall and thus resume greater importance for sustained agriculture and food security.

The millets are classified into major and minor millets based on various factors. The major millets are sorghum *(*jowar) and pearl millet (bajra) and finger millet (ragi/mandua) whereas foxtail millet (kangni/Italian millet), little millet (kutki), kodo millet, barnyard millet (sawan/jhangora), proso millet (cheena/common millet), and brown top millet (korale) are categorized under minor millets.

In view of the above, the present study was planned with the following broad objective: To document the time trends in production of millets in Gujarat, its consumption pattern in urban Vadodara and development of recipes from millets to prevent NCDs.

In view of the above the present study was planned with the following specific objectives:

- To document the time trends of production of millets in India and Gujarat from the available secondary data source.
- To study the consumption pattern of millets in Gujarat from the available secondary data source.
- To assess the consumption pattern of millets among urban households of selected individuals with their consent in Vadodara.
- To develop 5 recipes each using selected major and minor millets for prevention of NCDs.

The study was approved by the institutional ethical committee wide community number: IECHR/FCSC/2020/48.

The study was divided into three phases:

Phase 1: Documentation time trends in production and consumption of millet in India and Gujarat.

The documentation of time trends in production and consumption of millets in India and Gujarat was done using reports, articles and documents such as:

1. Agricultural statistics at a glance,2019
2. 4th Advance Estimate 2019-20
3. AERC Report 2012
4. FAO reports
5. State of Gujarat agricultural report 2011-12
6. NNMB (2002 to 2017)
7. Millets future of food and farming (FIAN, India 2015)
8. Supporting millets in India (policy review & suggestions for actions, 2012)
9. Millet support policies, 2012
10. Research articles

Highlights of the findings are:

- Production of millet in India and Gujarat shows decreasing trend.
- Bajra is the most common millet grown and consumed in Gujarat.
- Consumption pattern of millet also shows decreasing trend in India and Gujarat.

Phase 2: Consumption pattern of millets among urban population of Vadodara.

In the present study consumption pattern of millets was determined using pre tested semi structured questionnaire. Total 100 households were interviewed from four zones of urban Vadodara.

- In the study 98 percent of the respondents were Hindus and approximately 50% of them were Gujarati.

- 62 percent of the respondents had family members who had co-morbidities such as obesity, diabetes, heart related problems etc.
- 87 percent of the respondents were aware about the benefits of millet consumption as most of them considered millets to provide health benefits, increase fiber in the diet, lowers blood sugar and lowers lipid profile.
- 84 percent of the respondents purchased millets from the market whereas 11 percent of the respondents had their own farm produced millets.
- It was reported that 95 percent of the households consumed millets.
- 75.4 percent of the respondents in the households preferred consuming moriyo during fasting.
- 75 percent of the respondents had an opinion that millets are not expensive when compared with cereals like wheat and rice.
- Only 30 percent of the respondents based on food frequency questionnaire and dietary recall reported consumption of bajra once a week whereas only 23 percent of them consume jowar once a month.
- Based on dietary recall, it was reported that 59% of the households in the study had the practice of consuming vegetarian diet, 29% of households consumed non- vegetarian diet and 12% of households consumed ovo- vegetarian diet.
- All the 100 households consumed all the three major meals (breakfast, lunch and dinner) on daily basis whereas only 65% , 26%, 19% and 17% of the households had prevalence of consuming snacks, bedtime, early morning and mid-morning meals on regular basis.
- Based on dietary recall, all households reported for consumption of food groups such as cereals, milk and milk products, oil/fats and sugar/honey. Consumption of roots and tubers was 82 percent reported by households vegetables consumption was 99 percent in households, consumption of pulses/ legumes/ nuts was 92 percent in households. Consumption of protective food group like fruits was reported by only 39% of households.
- Prevalence of co-morbidities in family members of the households was a significant factor which affected the consumption pattern of millets in the households.

Phase 3: Recipe development from selected major and minor millets for prevention of NCDs.

In the study six millets were selected from which five recipes from each were planned for one serving and nutritional values were also calculated. The groups of selected millets are Pearl millet, Sorghum, Finger millet, Kodo millet, Barnyard millet and Amaranth.

The average content of energy in recipes is 232.66 ± 56.51kcal. The average protein content of the recipes is 6.55 ± 2.21g. The average content of carbohydrates in the recipes is 32.32 ±10.31g. The average content of fats in the recipes is 7.72 ± 2.60. The average content of dietary fiber, calcium and iron are 5.20 ± 1.78 g, 91.10± 75.61mg and 2.32 ± 0.90 mg respectively.

CONCLUSION

It can be concluded that production and consumption of millets is showing decreasing trends over the years regarding its consumption of millets, among urban households also regular consumption of millets was not reported by the households. It was thought worthwhile to analyze millet consumption, was reported by the households with presence of co-morbidities in the family, age, education, occupation status of the respondent. It was found that all most all the respondents reported that their family members with co-morbidities like high blood pressure and diabetes consume millets. There was association seen between prevalence of co-morbidities in family members of the households and consumption of millets. However frequency of regular consumption of millets was not reported. With regards to age, years of education and occupation status did not show much difference in consumption of millets. There is a need for health promotion activities to promote consumption of millets on regular basis by the community.

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Apendix1: Questionnaire on A Survey on Consumption pattern of millets in households of Urban Vadodara.

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A Survey on Consumption pattern of millets in households of Urban Vadodara.

Zone: 1. East 2. West 3. North 4. South **Date: _____**

House/ flat no: _____ **Contact no: _____**

General details

1. Name of society:
2. Name of the respondent:
3. Education qualification of the respondent:
   1)10^{th} Pass 2) 12^{th} Pass 3) Graduate 4) Post graduate 5) PhD 6) Other (specify)
4. Religion:
   1) Hindu 2) Muslim 3) Christian 4) Others (Specify)
5. Occupation of head of the household:
   1) Service 2) Business 3) Government employee 4) Housewife 5) Other (Specify)
6. Occupation of the respondent:
   1) Service 2) Business 3) Government employee 4) Housewife 5) Other (Specify)
7. Ethnicity:
   1) Gujarati 2) Marathi 3) Kathiyawadi 4) Others (Specify)
8. Type of family:
   1) Nuclear 2) Joint 3) Extended Nuclear
9. Total members in the family: _____
10. <18 years _____
11. >18 to 59 years _____
12. >60 years _____
13. Total family income annually:_____
14. Do you or any family member has a medical history for any of the below mentioned medical conditions?
    1) Obesity/ Overweight 2) Diabetes 3) High blood pressure 4)Heart related problems 5) Constipation 6) Asthma 7) Hyperlipidemia 8) Other (specify)

Consumption of millets

15. Are you aware about millets?
    1) Yes 2) No
16. Can you name common millets?
    1) Bajra 2) Jowar 3) Ragi 4) Kodari 5) Other(specify)
17. Are you aware about the benefits of consuming millets?
    1) Yes 2) No
18. If yes, for which reason?
    1) Weight loss 2) Lowering blood sugar 3) Lowering lipid profile 4) To increase fiber in diet 5) Increase iron 6) Other (specify)
19. What is the source of information?
    1) Print Media 2) Television 3) Family Friends 4) Doctor 5) Nutritionist/ Dietician 6) Other (specify)
20. Do you purchase millets?
    1) Yes 2) No
21. If yes, which are they?
    1) Bajra 2) Jowar 3) Ragi 4) Kodari 5) Other (specify)
22. How frequently do you purchase millets?
    1) Weekly 2) Monthly 3) Sometimes 4) As and when required 5) Seasonally 6) Other (specify)
23. Do you purchase any readymade item prepared from millets from the market?
    1) Yes 2) No
24. If yes, which items?

    _____
25. Are millets consumed in your house?
    1) Yes 2) No
26. If yes, how frequently?
    1) Daily 2) Weekly 3) Sometimes 4) Occasionally 5) Seasonally
27. Which millet is most commonly consumed in your family?
    1) Bajra 2) Jowar 3) Ragi 4) Kodari 5) Other (Specify)
28. In which form/recipe is millet consumed?

    _____
29. Who consumes millets in your family?
    1) All members 2) Adults 3) Old age people 4) Children
30. Why do you consume millets?
    1) Weight loss 2) Lowering blood sugar 3) Lowering lipid profile 4) To increase fiber in diet 5) Increase iron 6) Other (specify)
31. Does any member of your family consume any specific millet?
    1) Yes 2) No
32. If yes, specify? _____

33. Why do he/ she consumes that?

_____

34. Who advised him/ her to consume?

_____

35. Since when is he/she is consuming the particular millet?

_____

36. Any impact of millet consumption observed by the members who are consuming?

_____

37. In your family have you consumed any millets during (name them)

Last week	Last 30 days

38. Do you consume any millet's during fasting?
    1) Yes 2) No
39. If yes, specify? _____
40. How much do you consume millets during fasting?

_____

41. What are the recipes which are consumed during fasting?

_____

42. Why it is consumed?

_____

43. Do you prepare any special items from millets?
    1) Yes 2) No
44. If yes, for which of the following group :
    1) Pregnant women 2) Lactating mother 3) Elderly 4) Other (specify)

_____

45. Do you prepare any items from millets on any occasions?
    1) Uttrayan 2) Holi 3) Shravan 4) Adhik Mas 5) Other (specify)

_____

46. Have you prepared any items from millets during this Covid19 pandemic?
    1) Yes 2) No
47. If yes, which items specify? _____
48. Is there any custom of consuming samo by female member on the day of sama panchami? (next day of Ganesh chaturthi)
    1) Yes 2) No

49. If yes, how much quantity of samo is consumed?

_____

50. Do you find millets more expensive then cereal grains like wheat and rice?

1) Yes 2) No

51. If yes, which millets are more expensive then wheat and rice (specify)

_____

Frequency of millet consumption

Sr. no	**Name**								
		Everyday	**Alternate days**	**Once a week**	**Once a month**	**Seasonally**	**Occasionally**	**Rarely**	**Never**
1	Pearl millet (Bajro)								
2	Sorghum (Juvar)								
3	Finger millet (Ragi)								
4	Kodo millet (Kodari)								
5	Foxtail millet (Kang/Italian millet)								
6	Little millet (Kutki)								
7	Barnyard millet(Samo/ Jhangora)								
8	Proso millet (Cheena/common millet)								
9	Brown top millet (Korale)								
10	Quinoa								
11	Amaranth (Rajagro)								
12	Buckwheat (Kuttu)								
13	Others								

Household Dietary Intake (24 hours dietary recall)

1. Type of diet: Vegetarian/ Non vegetarian/ Ovo vegetarian

2. Number of meals generally consumed throughout the day in the household.

Meals	Consumed
Early morning	
Breakfast	
Mid morning	
Lunch	
Snacks	
Dinner	
Bedtime	

Meals	Menu	Ingredients	Quantity (g)
Early morning			
Breakfast			
Mid morning			
Lunch			
Snacks			
Dinner			
Bedtime			
Any food ordered from outside?			

Sr. no.	Food groups		Sr. no	Food groups	
1	Cereals		7	Fish and seafood	
2	Roots and tubers		8	Pulses/legumes	
3	Vegetables		9	Milk and milk products	
4	Fruits		10	Oil/fats	
5	Meat, poultry		11	Sugar/honey	
6	Eggs		12	Miscellaneous	

Health promotion

Those who are not consuming or aware millets at all or not on daily basis:

Would you like to know about benefits of consuming millets daily?

1) Yes 2) No

If yes, Millets are a group of highly variable small-seeded grass (barchatiu dhaniya), widely grown around the world as cereal crops or grains for fodder and human food. The most commonly consumed and produced in Gujarat are Bajra, Jowar, Ragi and Kodari. Millets provide some of the health benefits involved in protecting heart health and reduci ng migraine symptoms, Protection from diabetes, digestive system improvement,decrease d risk ofcancer, detoxifying the body, improving respiratory fitness, optimizing energy levels and strengthening the immune system and nerve and muscle fitness.

After understanding the benefits of millets, would you like to incorporate millets in your daily diet?

1) Yes 2) No