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# ALTERNATIVE MICROBIOLOGICAL MEDIA FROM VARIOUS LOCALLY AVAILABLE CROPS: A REVIEW

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***Abstract:*** **Sorghum, millet, and soybean are major food and cash crops in dry and semiarid parts of developing nations such as Ethiopia, and they include a variety of nutrients and minerals that are essential for a variety of uses. Instead of utilizing the expensive standard media (PDA, NA, EMB agar, McConkey agar, and Rainbow salmonella agar), locally available sorghum, finger millet, and soybean were used to prepare/formulate alternative microbial culture media. This review's major purpose is to generate alternative microbial culture media from locally farmed sorghum, finger millet, and soybean crops, as well as explanation of the cereals, microorganism and culture media.**

***Keywords:*** **Cereals crops, Culture media, Microorganism, Nutrients, Agar, Gelling Agent.**

## 1. INTRODUCTION

Microbiological research relies on the ability to cultivate and retain microorganisms in the laboratory by using culture media that provide the required nutrients for growth as well as appropriate environmental conditions (Willey *et al.,* 2008). To grow and reproduce, microorganisms require nutrients, a source of energy, and specific environmental conditions. Microbes adapt to the habitats that are best suited to their demands in the natural world, but in the laboratory, these requirements must be supplied by a culture medium and physical growth conditions (Simin, 2011). When preparing a medium for microbial growth, take into account the availability of carbon as an energy source, nitrogen as a supply, and other growth elements required by the organisms (Laleye *et al.,* 2007). In 1675, van Leeuwenhoek used a fluid generated by soaking peppercorns in water to provide ideal conditions for microbes. Koch later produced a solid medium when he described the use of boiling potatoes sliced with a flame-sterilized knife in cultivating bacteria in 1881 (Adesemoye and Adedire, 2005). Some microbes may acquire energy directly from sunlight, while carbon can be obtained in either organic or inorganic forms, such as carbohydrates or carbon dioxide (Madigan et al., 2000). The nutrients essential for cellular growth and maintenance must be provided in both quality and quantity in laboratory media used to cultivate microorganisms.

A medium is a solid or liquid preparation that contains materials for bacteria, animal cells, or plant tissue cultures to be cultured (grown) (Talaro, 2004). The provision of chemicals that can be utilized as food is required for the cultivation of organisms in a laboratory. "Culture medium" refers to nutritional preparations that bacteria can use as food. A nutrient requirement varies depending on the microorganism. As a result, culture media come in a variety of shapes and compositions, depending on the organism to be cultured. A medium can be designed to be either permissive, allowing whatever organisms are there to flourish, or limited, allowing only a subset of those organisms to grow (Ryan and Ray,

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2004). This could be in the form of a dietary requirement, such as giving lactose as the sole source of carbon for energy, or including a specific antibiotic or other drug in order to select those organisms that are resistant to that substance. This has some parallels with defined and undefined culture media, which are made from natural sources and include an unknown combination of organic and inorganic elements, whereas defined media can be carefully customized to promote specific groups of organisms with specific characteristics (Madigan and Martinko, 2005).

Nutrient agar medium is a general-purpose medium for the culture of a wide variety of bacteria. Peptic digest of animal tissue, beef extract and yeast extract, sodium chloride, and agar make up the basic medium (Jadhav *et al.*, 2018). Potato dextrose agar is a general-purpose medium that can be used to grow a wide variety of yeasts. Potato infusion, dextrose, and agar make up this dish. Microorganisms are grown on commercially available media such as Nutrient agar, Potato dextrose agar, EMB agar, MacConkey Agar, and rainbow salmonella agar, although they are highly expensive (Annan-Parh *et al.*, 2010). The necessity to establish alternative media to various cultural media has grown critical, as most developing countries' traditional media are either unavailable or prohibitively expensive (Amadi and Moneke, 2012).

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Sorghum and millets, which are typically considered subsistence crops, are the most drought-tolerant staple cereal grain crops and require little agricultural fertilizer to grow (ICRISAT/FAO, 1996). Unlike maize and wheat, they are well adapted to African semi-arid and sub-tropical climates, and they are significant crops for future human usage, helping mankind cope with the current dilemma of expanding global population and dwindling water supplies. Because 95 percent and 90 percent of the world's millet and sorghum growing regions, respectively, are found here, they are underutilized essential resources as feed and bird food in most developed countries (Taylor, 2004).

After wheat, maize, rice, and barley, sorghum (sorghum bicolor L. Moench), a tropical grass grown predominantly in warmer climates, is the world's fifth most significant cereal crop in terms of both area planted and productivity (Taylor et al., 2006). It is drought-tolerant, requiring only 400mm of rain to cultivate, as opposed to maize, which requires 500–600mm of rain (Taylor, 2004). Ethiopia and other eastern African countries are considered origin and domestication centers, with the most genetic diversity for both cultivated and wild sorghum varieties (David, 1995). Nigeria is the highest producer, with 4.8 million tons, followed by Ethiopia with 3 million tons. They are the most economically important indigenous cereals, with high carbohydrate content (average starch content of 65.7–70.8), proteins, vitamins, minerals, and other nutrients (Cox et al., 1997).

Millet is a broad term that refers to a variety of small-seeded annual grasses grown as grain crops in temperate, subtropical, and tropical climates. Millet has outstanding nutritional quality, comparable to or better than several regularly consumed grains such as wheat and rice, although it has gotten less attention than these foods (Ragaee et al., 2006). They are mostly used as poultry pasture and bird feed in the western world. Pearl millet (Pennisetum americanum), foxtail millet (Setaria italica), finger millet (Eleusine coracana), proso millet (Panicum miliaceum), and small millet (Panicum miliare) have all been cultivated or grown in Africa and Asia from prehistoric times (Singh and Raghuvanshi, 2012). After sorghum, pearl millet, and foxtail millet, finger millet is the fourth most important millet (Upadhyaya et al., 2007). It is a small cereal that is native to Ethiopia but is widely farmed throughout India and Africa (O'Kennedy et al., 2006). They offer a lot of potential for preserving and improving food and nutrition security (Mal et al., 2010). Millets are high in calcium (0.38 percent), protein (6 percent–13 percent), dietary fiber (18 percent), carbohydrates (65 percent–75 percent), minerals (2.5 percent–3.5 percent), phytates (0.48 percent), tannins (0.61 percent), and phenolic compounds (0.3–3 percent), all of which are beneficial to one's health (Chandrasekara and Shahidi, 2011).

For millions of people in the Orient, soybean products have been their primary source of protein (Waggle and Kolar, 1979). Soybeans in their whole form are a great source of protein (Nelson et al., 1978). Protein makes up to 40% of the dry matter in soybeans, so there's a lot of it. Soybean is a high-yielding crop grown for human use. Soy bean protein is regarded as a high-quality protein since it contains the majority of the essential amino acids required by the human body.

Soybean breeders claim that it produces the best protein production per unit of land area. For a long time, it has been discovered to be the richest, cheapest, and easiest source of protein. Because of the manufacturing circumstances, the protein level of soybean products varies greatly. Soy flour and TVP (Textured Vegetable Protein), a processed type of soy flour, have been employed as protein sources in the creation of alternate culture media for bacterial and fungal growth (Uthayasooriyan et al., 2016).The goal of this research is to generate alternative microbiological medium from a variety of locally available low-cost materials, such as cereals and protein sources that are high in protein and carbohydrates. Sorghum, finger millet, and soybean are nutrient-dense grains that were employed to make the alternative culture media in this study.

## 2. A LITERATURE REVIEW

### DESCRIPTION, PRODUCTION, TAXONOMY, AND DISTRIBUTION

### SORGHUM, FINGER MILLET, AND SOY BEAN PLANT DESCRIPTIONS AND PRODUCTION

Sorghum (Sorghum bicolor/L Moench) is a tall grass that grows to a height of 0–6 meters. It has a robust trunk and deep, spreading roots. Long (0.3-1.4 m) and broad (1.1–13 cm), the leaves have flat or wavy borders. A panicle is a flower that is generally upright but can be recurved to produce a goose neck. The plant's development spans 110 to 170 days, according to Léder (2004), and is divided into three stages: emergence to floral initiation, floral initiation to flowering, and flowering to physiological maturity. Glumes frequently cover grain, also known as caryopse. After pollination, glumes are the maternal plant tissues in the panicle that hold the developing caryopses. The caryopse is rounded and bluntly pointed, with a diameter of 4–8 mm and a wide range of size, shape, and color. In sorghum, caryopse color is an essential feature that influences grain quality. The seed coat (testa or pericarp), germ (embryo), and endosperm make up the Sorghum caryopse (storage tissue). The testa of some sorghum genotypes is intensely colored. The R and Y genes are responsible for the presence of pigment and color in the body (Waniska, 2000). The Z gene controls the thickness of the testa layer, which is not uniform. A partial testa is present in some genotypes, while it is not visible or nonexistent in others. The embryonic axis (rudimentary root and shoot) and the scutellum, which serves as a storage organ, make up the germs of sorghum. Protein, sugar, oil, and minerals are all abundant in the germ. Vitamins, particularly B vitamins and vitamin E, are also present (Serna-Saldivar and Rooney, 1995). The endosperm is largely made up of starch and protein, with some fat and fiber thrown in for good measure (Waniska and Rooney, 2000).

*After wheat, rice, maize, and barley, sorghum bicolor is the fifth most important cereal crop in terms of production (FAO, 2005). Sorghum output in the world is estimated to be around 60 million tons per year, with a cultivated area of 46 million ha. The United States, Nigeria, Sudan, Mexico, China, India, Ethiopia, Argentina, Burkina Faso, Brazil, and Australia are the top producers. Burkina Faso is the world's leading producer and consumer of sorghum per capita (ICRISAT, 2009).*

In Ethiopia, sorghum is the third most significant crop after teff and maize in terms of sown area, while it is the second most important crop in terms of overall production after maize (CSA, 2012). Sorghum is currently produced by 5 million farmers, with 4 million metric tons produced from about 2 million hectares of land, resulting in a national average gain yield of around 2 tons per hectare (CSA, 2012). It encompasses 16% of the overall land dedicated to grains (cereals, pulses, and oil crops) and 20% of the area dedicated to cereals. Sorghum is grown in Ethiopia at altitudes ranging from 400 to 2500 meters. The three biggest producers of sorghum are the Oromiya, Amhara, and Tigray regions, which account for 86 percent of total land and 89 percent of total production in the last nine years. Sorghum accounts for more than a third of the grain diet in Ethiopia, and it is nearly entirely farmed by subsistence farmers to suit their needs for food, income, feed, brewing, and construction (McGuire, 2007).

### MILLET

Millets (which literally translates to "little seeds") are a diversified group of cereal crops that yield small seeds. Millets are a diverse group of grass plants from many genera that originated and were domesticated in Africa and Asia's tropical and sub-tropical regions (National Research Council, 1996). The grain is globular to oval in shape and measures 1.0 to 1.5 mm in diameter. The majority of millet has deep, powerful root systems and brief life cycles. The grain structure of millet is similar to that of other cereal grains, with three main parts: endosperm, germ, and pericarp. The pericarp is the grain's outermost layer, and it is made up of three layers: epicarp, mesocarp, and endocarp. Epicarp is made up of 1–4 layers and may contain pigments that give the grains color. The testa, or seed-coat, lies beneath the endocarp (McDonough and Rooney, 1989). The outer aleurone layer and starchy endosperm make up the endosperm. Underneath the seed covering are the aleurone cells. Peripheral, floury, and corneous components of the starchy endosperm can be distinguished. The corneous component is hard and vitreous-like, and it dominates the outside layer of the endosperm, whereas the floury component is soft and floury, and it dominates the core (Mcdonough et al., 1986). Millets serve a critical role in the food security and economies of many developing countries. They're widely grown in India, Africa, and China. Millet is believed to be one of the first cereals that humans farmed. The first written mention of millet cultivation dates from around 5,500 B.C. in China (Crawford, 2006). They are critical crops in semi-arid environments where other crops would ordinarily perish. They're simple to raise, naturally bio-diverse, and may be mixed in with a variety of crops. Millets were produced in 32 million tons over the world in 2007, with India producing the most (10,610,000 tons) (FAO, 2009). Millets are the world's sixth most important cereal, feeding one-third of the global population (Saleh et al., 2013). The most significant millet in the world is finger millet (Eleusine coracana), which originated and was domesticated in the sub-humid uplands of eastern Africa (National Research Council, 1996).

Millions of people in Africa, India, and Nepal eat finger millet as a main diet. Because finger millet is frequently mixed with other millets, the exact worldwide area under this crop is unknown. Millet covers 36.29 million hectares worldwide (FAO, 1991). The global yearly production of finger millet is estimated to be over 4.5 million tons of grain, with roughly two million tons produced in Africa and the rest generated in Asia (mostly India and Nepal). It is Africa's second most significant crop, accounting for 8% of all farmed land and 11% of global millet production (Siwela *et al.*, 2007). 405,000 hectares in Uganda, 320,000 hectares in Tanzania, and 90,000 hectares in Kenya are among Africa's top producers of finger millet (FAO, 1991). It is native to eastern Africa, according to Tadesse and Kebede (1993), where the oldest domesticated specimen of this crop was discovered in an ancient site in Axum, Ethiopia, dating back about 5000 years. On average, it accounts for 4% of total cereal yield and 5 percent (228, ha) of total cereal producing area. In the regions of Gojjam, Gonder, Wollega, Iluababora, Gamo-Gofa, Eastern Hararghe, and Tigray, it is a significant crop. In the country's central rift valley, including Arsi Negele, Shashemene, and Siraro Woredas, this became a particularly important crop (Shimelis et al., 2009). Because of its great nutritional value and excellent storage properties, the crop is mostly farmed by subsistence farmers and serves as a food security crop (Dida *et al.*, 2007).

**SOYBEAN (*GLYCINE MAX, L. MERRILL*)**

Soybean was first grown in Eastern Asia, specifically China, Korea, and Japan, and then moved to Europe, America, and other parts of the world in the 18th century (Ngeze, 1993). It was utilized as food and a component of medications as far back as 5,000 years ago, according to Chinese history (Norman et al., 1995). Other putative genesis places for the genus Glycine have been identified by some academics include Australia and Eastern Africa (Addo-Quaye et al., 1993). It is widely farmed in temperate and tropical regions, including China, Thailand, Indonesia, Brazil, the United States, and Japan, where it has become a major agricultural crop and a substantial export item (Evans, 1996).

Soybean was first introduced to Africa in the early nineteenth century via Southern Africa (Ngeze, 1993), and it is currently found throughout the continent (Wikipedia, 2009). Shurtleff and Aoyagi (2007) speculated that it may have been introduced earlier in East Africa, given the region's long history of trading with the Chinese. Soybeans were cultivated in Tanzania in 1907 and Malawi in 1909, according to the same report. The soybean was first introduced to Ghana by Portuguese missionaries in 1909. Because of the crop's temperate origins, this early introduction did not succeed (Mercer, Quarshie, and Nsowah, 1975).

However, real efforts to establish the crop's production in Ghana began in the early 1970s. The collaboration between Ghana's Ministry of Food and Agriculture (MoFA) and the International Institute of Tropical Agriculture (IITA) resulted in this (Tweneboah, 2000).

Soybean (Glycine max) is a prominent oilseed grown as a commercial crop in over 35 countries (Smith and Huyser, 1987). Finer brown or gray hairs cover the stem, leaves, and pods. The leaves have three to four leaflets per leaf and are trifoliate. The fruit is a hairy pod with two to four seeds that grows in clusters of three to five. Each pod is five to eight centimeters long and contains two to four seeds (Rienke and Joke, 2005). Soybean seeds come in a variety of sizes, and the seed coat color varies from cream to black to brown to yellow to mottle. The mature bean's hull is tough, water-resistant, and protects the cotyledons and hypocotyls (Wikipedia, 2009). Soybean fruit is simple or crescent-shaped,

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measuring 3-7cm in length and containing 1 or 2 seeds, yielding 115-280g from 1000 seeds. On the fodder, the seeds weigh around 180-200g. Green unripe seeds ripen to light-yellow, green, and brown in color. In actuality, seeds from several cultivars are used, which affect the color and shape of the seeds. Modern cultivars feature spherical soybean seeds, with yellow and green colors being the most desirable (Sikorski, 2007).

As a result of the multiple benefits received from the crop, soybean production is fast rising all over the world. The world's current soybean output is 220 million metric tons per year, with the United States (32 percent), Brazil (28 percent), Argentina (21 percent), China (7 percent), India (4 percent), Paraguay (3 percent), Canada (1 percent), and others (4 percent) as the top seven producers (USDA, 2007). According to FAO data from 2005, the world's total land area under soybean cultivation was 95.2 million hectares per year, with a total production of 212.6 million tons. The United States (29 million hectares), Brazil (23 million hectares), and Argentina (14 million hectares) were the top three producers (IITA, 2009). Masuda and Goldsmith (2008) also broke down the world soybean production of 94 million hectares as follows: the United States produced over 30 million, Brazil nearly 22 million, Argentina 15 million, China 9.2 million, India 8.2 million, 20 Paraguay 2.2 million, and Canada one million hectares, respectively. According to the same source, soybeans were planted on an average of 1.16 million hectares in Sub-Saharan Africa in 2005, with an average yield of 1.26 million tons of grain. Nigeria (601 000 hectares), South Africa (150 000 hectares), Uganda (144 000 hectares), Malawi (68 000 hectares), and Zimbabwe (61 000 ha) were the African countries with the highest producing areas, according to Rynek (2010).

## TAXONOMY

Pliny (about 60–70 A.D.) was the first to write a written description of sorghum, and it was not mentioned again until the fifteenth century. Moench erected the genus Sorghum and named the sorghums S. bicolor in 1794, while Person offered the name Sorghum vulgare in 1805. Clayton advocated Sorghum bicolor (L.) Moench as the correct name for cultivated sorghum in 1961, and it is now widely recognized (Doggett, 1988). Sorghum (Sorghum bicolor L. Moench) is a member of the Andropogonae tribe of the Poaceae family. Eu-sorghum, Chaetosorghum, Heterosorghum, Para-sorghum, and Stiposorghum are the five subgenera of the genus Sorghum. Although useful, this classification does not reflect evolutionary relationships (Dillon *et al*. 2004). Sorghum is made up of cultivated species such as Sorghum bicolor (L.) Moench and its subspecies drummondii and arundinaceum, as well as wild species such as Sorghum x alum Parodi, Sorghum halepense (L.) Pers., and Sorghum propinquum (Kunth) Hitchc (deWet 1978). The Eu-sorghum section is thought to have originated in Africa or Asia (DuVall and Doebley, 1990). Sorghum macrospermum and Sorghum laxiflorum, both annuals and polyploids, make form the sections Chaetosorghum and Heterosorghum (Lazarides et al., 1991; Wu, 1990). Ten species of Stiposorghum are native to northern Australia and Tasmania (Lazarides et al. 1991). Seven African, Asian, Australian, and Central American species make up the Para-sorghum Section. In each section, the baseline number of chromosomes for each species is five. The majority of Parasorghum and Stiposorghum species are diploid ($2n = 10$) with a few tetraploid or hexaploid species.

The family Poaceae, subfamily Chloridoideae, includes finger millet (Eleusine coracana subsp. coracana $2n = 4x = 36$). They include at least 14 species and 10 genera. Pearl and tiny millets are the most commonly grown millets. Finger, proso, foxtail, barnyard, tiny, and kodo millet are all small millet varieties. Millets such as fonio, teff, browntop, and Australian millets are less typically farmed (Rachie, 1975). There are various millet variations within each millet type. Seed qualities, growth region, grain composition, breeding, and genetics are just a few of the elements that might affect the variants within the types (Gelinas and Mckinnon 2006).

### Soybean (Glycine max (L.) Merrill)

Soybean (Glycine max (L.) Merrill) is a leguminous plant that belongs to the leguminosae botanical family. It belongs to the Papilionideae subfamily, which includes 500 genera and over 12,000 species of peas, beans, lentils, and peanuts (Shurtleff and Aoyagi, 2007). Glycine is divided into two subgenera: Glycine, which includes seven perennial wild species confined to Southeast Asia, and Soja, which includes Glycine max and its wild progenitor, Glycine soja, both of which are domesticated and commercially important soybeans. Both are annuals that thrive in tropical, subtropical, and temperate environments. They have 40 chromosomes ($2n = 2x = 40$) and are a self-fertile species with a low out-crossing rate of less than 1% (Norman *et al.*, 1995). Linnaeus first proposed the genus name Glycine in his first edition of Genera Plantarum, with the cultivated species Phaseolus max L. first appearing in the publication "Species Plantarum." Merrill offered the name Glycine max (L.) Merr in 1917, and it has since become the accepted name for this valuable plant (Wikipedia, 2009).

**GRAIN CURRENTLY IN USE: SORGHUM, MILLET, AND SOYBEAN**

Rooney and Waniska (2000) give an excellent summary of sorghum's usage in food and business. Sorghum is largely farmed for animal feed in the United States, Australia, and other wealthy countries. Grain, on the other hand, is used for both human sustenance and animal feed across Africa and Asia. More than 300 million people in poor nations are projected to rely on sorghum as their primary source of energy (Godwin and Gray, 2000). According to the United States National Sorghum Producers Association (2006), nearly half of the world's sorghum grain production is consumed as human food, with Africa and Asia accounting for 95% of overall food use (FAO, 1995). In Africa, the Middle East, Asia, and Central America, sorghum grain is consumed in a number of ways, including porridge, steam-cooked food, tortillas, baked dishes, and as a beverage (CGIAR, 2009). In many African countries, sorghum accounts for a significant share of overall calorie consumption (FAO, 1995). Sorghum is consumed almost entirely for food in China and India. Sorghum is genetically closer to maize than wheat, rye, or barley, and as a result, it is considered a safe meal for celiac disease patients (Ciacci et al., 2007; U.S. Grains Council, 2008). Several million tons of sorghum is used for traditional beer brewing throughout Africa, as well as lager and stout production in the west, east, and central regions. According to research from Mexico, waxy sorghum (a mutant type with about 100% amylopectin) may be beneficial for brewing; nevertheless, normal sorghum (roughly 75% amylopectin and 25% amylose) is more typically utilized for beer production (Del Pozo-Insfran et al., 2004; Figueroa et al., 1995).

Sweet sorghum biomass contains sugar that is easily fermentable, making it an excellent raw material for fermentative hydrogen production. Sorghum has been intensively researched as an energy crop for bioethanol and methane generation, as Richards et al. (1991) noted, but it can also be exploited as a possible source for hydrogen production. In recent years, ethanol production from sorghum grain or sweet sorghum biomass (stalks) has piqued attention (Ali et al., 2008; Wang et al., 2008; Zhao et al., 2008). To make ethanol from sorghum grain, the whole grain is crushed, gelatinized, and enzymes are used to turn it into fermentable carbs. Distillers' grains, a by-product, contains about 30% protein and is extensively used as livestock feed in both wet and dry forms (Al-Suwaiegh et al., 2002; Rooney and Waniska, 2000).

Millets have a number of health benefits for customers. People with celiac disease can eat these crops since they are gluten-free (Gabrovska et al., 2002). They can also lower glycemic response, which is beneficial in the treatment of type 2 diabetes, as well as reduce the incidence of duodenal ulcers, anemia, and constipation, according to Choi et al. (2005).

Millets are mostly utilized as an ingredient in composite mixes to manufacture gluten-free and low glycemic index (GI) food items in North America and Europe. Millet items produced entirely with millet flour are extremely unusual. Millets, on the other hand, are the major ingredient in the preparation of traditional dishes and beverages in African and Asian countries (Saleh *et al.*, 2013).

The grain is used to make native bread, injera, porridge, cake, soup; traditional breakfast called "Chachabsa," malt, local beer, and distilled spirit (Areki) in Ethiopia, either alone or in combination with teff, maize, and barley (Mulatu et al., 1995).

Millet consumption has been lower than that of main grains such as rice, wheat, and corn, despite its great nutritional characteristics and endurance for poor growing circumstances. Small millets have received the greatest attention among millets. Millets must be made one of the most significant commodities in our food basket by raising awareness of their outstanding nutritional qualities.

Soybean Soy is more protein-rich than any other popular vegetable or legume dietary source in Africa, according to Dugje et al. (2009). It contains a protein level of 40% on average. On a dry matter basis, the seeds contain roughly 20% oil, which is 85 percent unsaturated and cholesterol-free.

Soybeans, according to Borget (1992), contribute to the nutrition of both humans and domestic animals. Soybeans contain a wide range of nutritional and therapeutic characteristics, as well as industrial and commercial uses and agronomic benefits such soil conservation, green manure, compost, and nitrogen fixation. Processed into soy oil, soy milk, soy yogurt, soy flour, tofu, and tempeh, as well as cooked and eaten as a vegetable (Rienke and Joke, 2005; MoFA and CSIR, 2005). Soybeans, according to Rienke and Joke (2005), provide a lot of high-quality protein and are a good source of carbs, oil, vitamins, and minerals. According to studies, the protein content of one kilogram of soybean is similar to the protein content of three kilos of meat, 60 eggs, or ten litres of milk. Furthermore, the price of a kilogram of soybeans is substantially lower than the price of a corresponding quantity of meat or eggs (Ngeze, 1993). As a result, it would make an ideal meat alternative in developing nations, where animal protein-rich meals like meat, fish, eggs, and milk are often unavailable and prohibitively expensive for resource-poor families.

After oil extraction, the cake obtained from soybeans is a major source of protein feed for livestock such as poultry, pigs, and fish. Soybean production has increased dramatically, resulting in huge increases in chicken, pig, and fish farming (Abbey et al., 2001; Ngeze, 1993; MoFA and CSIR, 2005). After the seed is extracted, the haulms make excellent feed for sheep and goats (Dugje et al., 2009).

Soybeans are reported to contain anti-nutritional chemicals that lower the nutritional content of the beans and are harmful to one's health, thus they must be eliminated before consumption. This isn't a concern because these compounds can be eliminated by soaking and/or "wet" boiling the beans, leaving a useful product that is safe for people (Rienke and Joke, 2005; Ngeze, 1993).

Soybeans are also said to provide a number of health advantages. Regular use of soy foods has been linked to a lower risk of hormone-related cancers such as breast cancer, prostate cancer, and colon cancer (Wikipedia, 2009). Due to the oestrogen-like effect of soy isoflavones, it also reduces menopausal symptoms. According to research, eating soy products on a daily basis lowers the risk of cardiovascular disease by lowering total cholesterol, low density lipoprotein cholesterol, and plaque build-up in arteries, which can lead to stroke or heart attack (The Mirror, 2008). The high quality protein, low cholesterol oil, and other nutritional values are helpful in the treatment of nutritional problems in children (MoFA and CSIR, 2005), diabetics, and vegans (Wikipedia, 2009).

## GRAIN SORGHUM, FINGER MILLET, AND SOYBEAN CHEMICAL COMPOSITION

### SORGHUM

The endosperm, which makes up the majority of the kernel, has a low mineral and oil content. The endosperm is responsible for the majority of the protein (80%), starch (94%), and B-complex vitamins (50 to 75%) in the kernel (FAO, 1995). The germ fraction of sorghum includes over 68 percent of the total mineral matter, 75 percent of the oil, and 15 percent of the protein of the whole kernel, and is high in minerals and B-complex vitamins. Sorghum bran has a low ash, protein, and fiber content while being high in fiber. The outer pericarp is removed during processing, which enhances the protein content while decreasing the cellulose, lipid, and mineral content of the grain.

### Carbohydrate Content

Starch, like other cereals, is the primary carbohydrate storage type in sorghum, with an average starch content of 69.5 percent to 76 percent (Jambunathan and Subramanian, 1987). Arabinoxylans (pentosans) in grains have been shown to alter the water balance and rheological qualities of the dough, as well as starch retrogradation (Vinkx and Delcour, 1996). They're polysaccharides having a xylan backbone and arabinose residues branching off of it. The carbohydrate composition and structural characteristics of sorghum arabinoxylans with good roti making quality were assessed (Nandini and Salimath, 2001).

When compared to wheat flour, sorghum contains similar amounts of starch but has much lower –amylase (40–50%) and amylolytic (10%) activity (Zhumabekova et al., 1978).

### PROTEINS

The second most important component of sorghum grains is proteins. Sorghum protein content is influenced by genetic and environmental variables. Sorghum protein concentration has been shown to fluctuate with variations in amino acid composition (Waggle and Deyoe, 1966). Sorghum has a protein level that is comparable to wheat and maize. Sorghum grains are known for their high fiber content and poor nutrient digestion, both of which have a negative impact on customer acceptance. Sorghum cultivars with lower levels of lysine, threonine, and total sulfur amino acids have been found (Khalil *et al.*, 1984). The leucine/isoleucine ratio was found to be unbalanced when compared to the FAO/WHO reference protein, and baking reduced tannin levels in the cultivars evaluated to zero. When compared to unfermented breads, fermented breads showed higher vitamin B12 and pantothenic acid levels but lower P levels (WHO, 1973). The amounts of amino acids in fermented bread were slightly lower.

## MILLET

The millet seed coat is an edible component of the kernel and is high in phytochemicals such as dietary fiber and polyphenols, as well as minerals, particularly calcium (Chethan and Malleshi, 2007), while according to the US National Agricultural Statistics Service,

In terms of minerals, dietary fiber, and amino acids, finger millet grain is more nutritious than most cereal grains, according to the Food Research Council (1996). (Shimelis et al., 2009).

## CARBOHYDRATES AND DIETARY FIBER

Finger millets are high in soluble sugar, pentosans, cellulose, and hemicelluloses, but low in soluble sugar, pentosans, cellulose, and hemicelluloses (Iren Ledde, 2004). Carbohydrates make about 70–76 percent of the total weight of the finger millet grain, according to Bhatt et al. (2003), and are made up of 61.8 percent starch, 7.9 percent cellulose, 0.8 percent reducing sugars, 0.5 percent dextrins, and 4.9 percent pentosans. Raffinose, sucrose, glucose, fructose, and maltose are among the sugars contained in finger millet grain (McDonough et al., 2000).

Insoluble (IDF) and soluble (SDF) dietary fiber are abundant in finger millets, which have equivalent or even higher total dietary fiber (TDF) than other cereals. The total dietary fiber content of finger millet grain (22.0 percent) is higher than that of most other cereal grains (e.g., wheat, rice, maize, and sorghum have 12.6, 4.6, 13.4, and 12.8 percent, respectively) (Klopfenstein, 2000). Dietary fibers are classified as water soluble or insoluble, which represents various physiochemical qualities and ability to cause different biological effects. Chethan and Malleshi (2007) found 15.7 percent insoluble dietary fiber and 1.4 percent soluble dietary fiber in finger millet grain, while Shobana and Malleshi (2007) found 22.0 percent total dietary fiber, 19.7 percent insoluble dietary fiber, and 2.5 percent soluble dietary fiber in finger millet grain.

## PROTEIN

Protein is millet's second most important component. Although finger millet contains about 7% protein, Sharman (2001) reports considerable fluctuations in protein concentration ranging from 5.6 to 12.70 percent. Singh and Srivastava (2006) studied 16 finger millet cultivars and discovered that their yields varied from 4.88 to 15.58 percent, with a mean of 9.728 percent. While Shimelis et al. (2009) found that the protein content of improved and local varieties of finger millets in Ethiopia ranged from 6.26 to 10.5 percent, protein levels in brown and red-seeded cultivars are generally lower, whereas levels in white seed cultivars and the wild subspecies Africana are higher (10 to 14 percent) (Dida and Devos, 2006).

The protein level is similar to rice (7.9%) and lower or similar to other millets, sorghum, and wheat (11.0, 9.6,9.0,7.9, and 12.6 percent pearl millet, tef, fonio, sorghum, and wheat, respectively) (Obilana, 2003, Klopfenstein, 2000).

## LIPIDS (CRUDE FAT)

Finger millet has a crude fat level of 1.3 to 1.8 percent, according to studies (Bhatt et al., 2003; Singh and Srivastava, 2006). The lipids in sorghum and millets are classified as polar, nonpolar, and non-saponifiable, and they can be found as free, bound, or structured lipids. The non-polar lipids, such as triglycerides, are the most prevalent (fats and oils). The primary elements of finger millet grain are palmitic, oleic, and linoleic acids, which make up around 5.2 percent of the total lipid content (McDonough et al., 2000).

## SOYBEAN (GLYCINE MAX (L) MERRILL)

Soybean seeds include 5.6 percent to 11.5% water, 32 to 43.6 percent crude protein, 15.5 to 24.7 percent fat, 4.5 to 6.4 percent crude ash, 10 to 14.9 percent neutral detergent fiber (NDF), 9 to 11,1 percent acid detergent fiber (ADF), and 31.7 to 31.85 percent carbs on a dry matter basis (NRC, 1998; Poultry Feeding Standards, 2005). contain a lot of hemicellulose and pectin and relatively little starch (4.66–6.7%). Protein from soybeans has more lysine, tryptophane, isoleucine, valine, and threonine than protein from rape, but less sulfuric amino acids (NRC, 1998; Poultry Feeding Standards, 2005).

Sulfur amino acids and tryptophane decrease the nutritional value of soybean protein. Soybean has the highest protein, lysine, and methionine digestibility of any plant. Soybean protein contains enough amino acids to augment grain protein and meet the needs of animals.

Banaszkiewicz (2000) found that soybean protein synthesized using chemical techniques had a lower nutritional value than rape cakes.

Triglycerides make up nearly all of the lipid components in soybean seeds, with a high amount of polyunsaturated (linoleic and linolenic) and unsaturated (oleic) fatty acids. The fatty acid composition of the lipid component of soybean seeds is over 80%, with linoleic acid accounting for roughly 50% (ENV/JM/MONO) (2001).

A multitude of factors, including origin, tillage conditions, variety, and technical method, influence the concentration of mineral components in soybean seeds. There is a lot of phosphorus in these goods (Van Eys *et al.*, 2004).

## MICROORGANISMS

Microorganisms are almost ubiquitous, diverse, and necessary for human survival. One of the criteria for studying them is the preparation of appropriate culture media. Microorganisms flourish in a range of habitats and have diverse development requirements, such as nutrition, pH, osmotic pressure, and temperature. Nearly 99 percent of all microorganisms are still unculterable due to a lack of sufficient variety in media composition and reproduction of the identical environmental conditions in the laboratory. Given the existing restrictions of microbial growth in the laboratory, the development of novel media should be a priority for modern biology.

Microbial culture media come in a variety of shapes and sizes, depending on the nutritional needs of the microorganisms. Microorganisms require a total of ten macroelements, including (C, O, H, N, S, P, K, Ca, Mg, and Fe). The first six components are used in the creation of carbohydrates, lipids, proteins, and nucleic acids, while the last four cations exist in the cell and serve a variety of functions. Microelements such as Mn, Zn, Co, Mo, Ni, and Cu are required by all microbes in addition to macroelements. They're mostly found in enzymes and cofactors. Growth factors, which are organic molecules, are also required by microorganisms.

## FUNGI

Fungi are eukaryotic, spore-bearing organisms with absorptive nourishment and no chlorophyll that reproduce sexually and asexually, according to microbiologists (Prescot et al., 1993). Fungi are microorganisms that are saprophytic or parasitic and are not found in plants or animals. Yeasts are unicellular eukaryotic fungi with features that are fundamentally different from bacteria, which are prokaryotic microorganisms.

## DISTRIBUTION

Fungi are mostly terrestrial organisms, with a few exceptions in freshwater and the sea. Many of them are pathogenic, infecting both plants and animals. Other organisms and fungi can create advantageous connections (Osman et al., 2013). Soil, water, plants, animals, and insects are all natural habitats for yeast, with plant tissues serving as a unique niche. Many commercial products are available for use as feed additives in animal nutrition and comprise a mixture of living and dead S. cerevisiae cells in varied quantities. Candida krusei is a yeast species that has been isolated from a variety of habitats, and its wide biotechnological role has piqued interest in recent years. It can be found in a variety of fermented foods and dairy products, and because of its opportunistic pathogenic character, it is most typically discovered in individuals with HIV–acquired immune deficiency syndrome and cancer patients. Patients' samples also include Candida guilliermondii, a less pathogenic yeast infection (Yadav et al., 2012).

## IMPORTANCE

Fungi have both helpful and detrimental effects on humans. Fungi, like bacteria and a few other kinds of heterotrophic organisms, play an important role as decomposers. Carbon, nitrogen, phosphorus, and other important body elements are released and made available to other species in this fashion (Prescot et al., 1993). Fungi are the most common cause of plant diseases, with over 5,000 species attacking commercially important crops, garden plants, and many wild plants. Fungi are also responsible for a wide range of diseases in both animals and humans (Omamor et al., 2007).

Many industrial processes involving fermentation require the use of fungi, particularly yeasts. They're also used to make some cheeses and soy sauce, as well as in the commercial synthesis of numerous organic acids and pharmaceuticals, as well as the production of many antibiotics and the immunosuppressive medication cyclosporine. Fungi have also been used as model organisms by geneticists and molecular biologists to study a number of eukaryotic processes (Osman et al., 2013). S. cerevisiae has a long history of usage in the food processing industry.

**NUTRITION AND METABOLISM**

Fungi thrive in dark, wet environments, although they can be found everywhere there is organic matter. The majority of fungus is saprophytes, meaning they get their nourishment from decaying organic matter. Fungi, like many bacteria, can produce hydrolytic enzymes that break down external substrates. The soluble compounds are then absorbed. They are chemoorgano-heterotrophy, meaning they get their carbon, electrons, and energy from organic matter (Prescot et al., 1993). Fungi are typically aerobic organisms. Some yeast, on the other hand, are facultatively anaerobic and can receive energy through fermentation, such as when making ethyl alcohol from glucose. The rumen of cattle contains obligatory anaerobic fungus. Yeasts are chemoorganotrophs, which means they get their energy from organic chemicals rather than sunlight. Carbon is largely derived from hexose sugars like glucose and fructose, as well as disaccharides like sucrose and maltose. Pentose sugars like ribose and alcohol can be metabolized by some animals. Yeast species are either aerobic (need oxygen for aerobic cellular respiration) or anaerobic (demand oxygen for anaerobic fermentation), but have aerobic energy generation techniques (facultative anaerobes) (Barnett, 1975).

**BACTERIA**

Bacteria are a vast collection of very small cells with immense fundamental and practical value.

**DISTRIBUTION**

Bacteria can be found in aquatic (oceans, ponds, lakes, streams, ice, and hot springs), terrestrial (surface soils, deep underground), and other creatures (plants and animals) all over the planet. E.coli is found in the digestive tracts of all species, including humans, as well as in the gut microbiomes of birds, reptiles, and fish, though less often (Leimbach et al., 2013).

**BACTERIAL AND FUNGAL/YEAST CULTURE MEDIA**

Bacterial medium can be classified as simple, synthetic, or complicated, depending on their nutritional composition. Simple media promote the growth of non-fastidious bacteria, and their chemical compositions are well understood. Synthetic media, such as Davis and Mingioli Medium, is made up of the bare minimum of components required for microbe development. However, in complicated media, such as Tryptic Soy Broth, the specific chemical composition is unknown. Solid nutrition agar medium, Stuart's semi-solid media, and nutrient broth liquid media are all examples of bacterial media. In 1675, van Leeuwenhoek used a fluid generated by soaking peppercorns in water to provide ideal conditions for microbes. Koch invented a solid medium for cultivating bacteria in 1881 when he described the use of boiling potatoes sliced with a flame-sterilized knife.

A pure culture is typically required for performing research on specific bacteria and the medium chosen for isolating and growing them is critical. As a result, many selective and differential media, such as MacConkey Agar and Blood Agar, have been developed, each of which contains specific components that distinguish one group of organisms from another. Different alternative media, such as Dorset medium and Petergnani medium for cultivating mycobacteria, have been produced by supplementing them with certain components to aid in further selective cultivation of bacteria. Dorset medium is made out of egg whites, egg yolks, and a sodium chloride solution (Wasas *et al.*, 1999). In addition to mycobacteria, egg-based media have been reported to support the development of pathogenic bacteria such as Streptococcus pneumoniae, Neisseria meningitides, and Haemophilus influenzae.

At pH ranges of 5 to 6, and temperatures ranging from 15 to 37 C, fungi require media with rich carbohydrate and nitrogen sources for growth. Natural and synthetic fungal culture media are the two main types. Natural media are made up of things like herbaceous or woody stems, seeds, leaves, maize meal, wheat germ, and oatmeal, among other things. Natural media are typically simple to create, but they have the drawback of being unknown in composition. Corn meal agar, potato dextrose agar, V-8 juice agar, and dung agar are some examples. Synthetic media, on the other hand, are made out of recognized substances. These media may be precisely copied each time they are made, and they contain predetermined amounts of carbohydrates, nitrogen, and vitamin sources. This includes Czapek-Dox medium, glucose-asparagine medium, and Neurosporacrassa minimum media. A general purpose media widely used for fungal growth is Sabouraud dextrose agar (SDA), which is nutritionally poor and has an acidic pH (5.6). In the isolation of fungal pathogens such as Cryptococcus neoformans and dermatophytes, selective media such as Inhibitory mould agar and Dermatophyte test medium are essential (Bhattacharya et al., 2002). To distinguish between Candida and Trichophytan species, agar supplemented with rice, casein, and other nutrients, such as cornmeal agar with Tween 80, has been utilized. Because most regularly used lab media are not cost-effective on a big scale, industrialists have begun to use a variety of inexpensive carbon sources. Fungi and bacteria from various sample sources have been grown using fruits and vegetables (Famurewa and David, 2008). Various researchers have documented the use of legume seeds (rice, chickpea, corn, etc.) as an alternate growth media for fungus and bacteria (Uthayasooriyan et al., 2016). Local cereal species found in Nigeria were evaluated as basal media by Adesemoye & Adedir (2005), who used three cereal meal extracts (corn, sorghum, and millet) as alternatives for potato in potato dextrose agar for fungus growth. Soychunk extract agar was used as a bacteriological medium by Antony et al. (2014). Sweet potato agar was utilized by Ojokoh and Ekundayo (2005) to cultivate yeasts. Annan-Parh et al. (2010) investigated cowpea as a low-cost alternative culture medium for bacteria growth. Cooked (boiled) cowpeas were utilized by the authors to extend the shelf life by up to three months.

**GELLING AGENTS**

Isolation of bacteria for the formation of pure culture was challenging in liquid media in the beginning. Because of the lengthy and painstaking methods, every attempt to prepare a pure culture using liquid media frequently results in contamination. As a result, a solid medium was required, which was accomplished by adding a gelling agent to the liquid soup. Robert Koch utilized gelatin as the first gelling agent to make a solid medium in 1881.

However, because it melted at roughly 35 oC and was eaten by microorganisms, he had difficulty using it. These issues led to the development of agar, an alternate gelling agent. The use of agar as a substitute for solid culture media was initially proposed by Angelina Fanny Eilshemus, wife of Walther Hesse, a Koch colleague. Agar has gradually gained popularity among scientists due to its stability at a wide range of temperatures (solidified at 32 to 42 degrees Celsius, melted at 85 degrees Celsius) and hence suitability for the growth of mesophilic organisms.

Furthermore, agar has no harmful effects on bacteria, has excellent diffusion properties, and is not digested by most bacteria. Agar is also known for its purity and metabolic inertness. Agar, on the other hand, is unsuitable for the cultivation of thermophilic bacteria and inhibits PCR in a concentration-dependent manner (Rath and Schmidt, 2001). Furthermore, the high cost of agar has made research exceedingly expensive, and the natural resources of agar (i.e., Gelidium sp., Gracillaria sp., and Pterocladia sp.) have been over-exploited, forcing the scientific community to explore for other alternative sources of gelling agents (Rath and Schmidt, 2001).

**pH**

Microbes' growth is influenced by the pH of the culture media. Any organism has a preferred pH range in which it thrives. A change in this pH value causes unwanted growth. For most bacteria, there is an orderly increase in growth rate as it approaches the optimal "pH" value and a corresponding orderly reduction in growth rate as it deviates from it. Each microbe species is classified into three categories based on its preferred pH range for growth and reproduction. Most bacteria have a pH range of 5 to 9 (with 7 being ideal), but they can be acidophilic (0 to 5.5), neutrophilic (5.5 to 8.0), or alkalophilic (0 to 5.5). (8.5 to 11.5) (Madigan *et al*., 2003).

Microorganisms, like other organisms, require a physiological pH within their cells. The capacity to survive in extreme pH circumstances, whether high or low is contingent on their ability to balance the environmental pH with physiological PH (Tregoning *et al.,* 2015). Microorganisms like Helicobacter pylori thrive in the stomach's acidic environment, therefore they produce urease, an enzyme that dissolves urea and reduces acidity (Degnan *et al.*, 2003). Other bacteria have evolved to exist in alkaline conditions, such as near black smokers and geological mineral fountains that spew highly alkaline materials into the sea (Tregoning *et al.*, 2015).

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A color change in pH indicators indicates a change in the medium's acidic or alkaline characteristics. They're employed in culture media to distinguish between distinct types of bacteria based on whether they produce acid or alkali. Eosin and Methylene blue, Bromothymol blue, Acid fuchsin, Phenol red, and other dyes are examples (Krulwich et al., 2011).

## 3. CONCLUSIONS

Sorghum and finger millet are indigenous food crops in Ethiopia that are getting attention because of their advantages in agronomical practice and important nutrient compositions. They are potential cheap sources of starch compared to other common sources of starch that can be used in different industrial applications. However, scanty research has been done on their utilization and their nutritional quantity for different purposes. To use this locally available sorghum, finger millet and soybean for the preparation/formulation of alternative microbial culture media instead of using the conventional media, which are very expensive? Especially for less developed countries like Ethiopia, it is very essential to look for other locally available, cheap and easily cultivated cereal grain crops for different applications requiring high costs.

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