Ashwin RAJ

Business Development Manager
Hexagon Nutrition

Ashwin Raj currently manages international business development with Hexagon Nutrition, India. He has a degree in Biotechnology and also holds an MBA from India. His articles on the importance and benefits of fortification have been published in several internationally peer reviewed journals. He has also represented Hexagon Nutrition in several national and international forums as a speaker covering fortification and its benefits.

Flour Fortification:

An effective medium to improve the nutritional status of people

"Turkey is one of the largest exporters of flour in the world and therefore serves as a central powerhouse to distribute fortified flour and help eradicate malnutrition in the world. Fortifying flour in Turkey can aid in curbing malnutrition in Central Asia and the Middle East since most of the flour is exported to these regions."

Flour is one of the oldest and most effective forms of food known to mankind. It is the dehydrated, ground product of cereal grains. Since ancient times, flour has remained an important commodity produced with the intention of enhancing the keeping quality of grains. It also offers other benefits like reduced storage space, availability of the product throughout the year besides easing cooking efforts. Flour is a staple that serves as an excellent source of energy for people around the world, though the source and form of the flour may vary across regions. Wheat, maize and rice serve as the most common sources of flour though the production of wheat flour remains the highest. Flour is a relatively economic solution to significant proportions of the world's population as compared to other staples.

Flour forms an inevitable part of the mo-

dern-day processed food segment. It is the basis of most baked goods, snacks, extruded products such as noodles, pasta and wafers – products that occupy a major portion of the retail shelf. However, processing of grains destroys the innate nutrients that pre-exist in its natural state.

FLOUR PROCESSING AND PRODUCTS

After harvesting, grains are subjected to a processing technology called milling. It is the process of grinding the grains to eventually produce flour. The grains are ground at different stages depending on the type of flour required for specific applications such as bread, cakes, buns, etc.

There are 3 broad layers that make a grain. The outer layer is the bran while the endosperm and germ make the inner layers. The process of refining destroys the bran and the germ thereby impairing the goodness of these layers that are otherwise rich in various nutrients and proteins. However, the endosperm remains relatively unaffected. But the overall nutritional profile of the whole grain is therefore, lost due to the harsh processing conditions such as heat and mechanical agitation.

After milling, the flour thus obtained is either directly available to the consumers in its original form or is procured as an ingredient and used in major applications as listed below:

Baked products: Flours of wheat, corn and rye are commonly used as the main ingredient in baking. The baking process involves the exposure of ingredients, including flour, to high temperatures ranging between 200°C and 250°C. Although bread is the most widely consumed form of flour, other products such as buns, biscuits, cookies, cakes, wafers, pizzas are also prominent choices.

Extruded cereal products: The durum variety of wheat is largely used to produce extruded wheat based snack products, wherein the wheat is generally ground, made into dough, and extruded with the help of extruders, and later dried at high temperatures in order to remove the moisture content. This process ensures in improving the shelf life or stability of the product. Extruded cereal products mainly include noodles, pasta and breakfast cereals.

In summary, although grains are preloaded with certain essential nutrients, processing conditions such as heat disrupt the nutritional profile of the processed food product. Thus, there arises a clamant need to restore the lost nutrients.

FORTIFICATION AND ITS BENEFITS

According to the World Health Organization (WHO) and the Food and Agricultural Organization of the United Nations (FAO), fortification is "the practice of deliberately increasing the content of an essential micronutrient, ie. vitamins and minerals (including trace elements) in a food irrespective of whether the nutrients were originally in the food before processing or not, so as to improve the nutritional quality of the food supply and to provide a public health benefit with minimal risk to

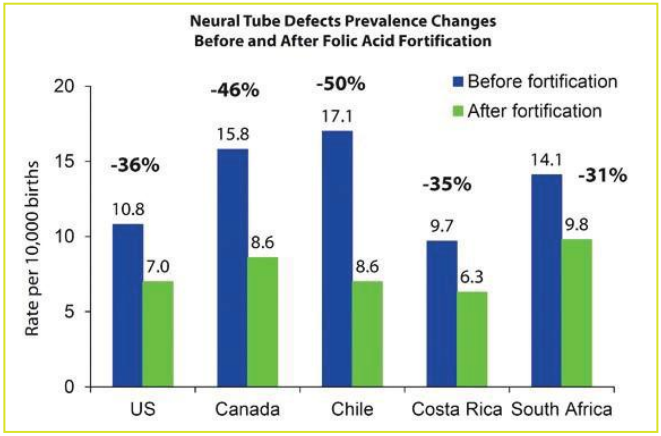
Fortified flour offers the following benefits:

- *Flour is one of the most consumed staples in the world and thus serves as an effective mode to propagate the concept of fortification*
- *Most micronutrients are highly compatible with flour*
- *Economic solution to uproot malnutrition*

health", whereas enrichment is defined as "synonymous with fortification and refers to the addition of micronutrients to a food which are lost during processing".

Fortification of flour offers multiple benefits to consumers, satisfying caloric requirements as well as alleviating the problem of hidden hunger. In the words of Mr. Kul C. Gautam – former Deputy Executive Director of UNICEF, cited by J.L. Nystrom, "You have the power to help improve the learning ability, productivity, and prosperity of millions of consumers around the world by supporting the fortification of cereal flours with essential micronutrients."

Fortification of wheat flour with vital micronutrients is believed to serve as an effective technique to counter the nutritional deficiencies faced by the global population.



Micronutrients for flour fortification

Fortification of wheat flour is a cost-effective tool for reducing micronutrient deficiencies and prevent birth defects such as neural tube defects that occur due to folic acid deficiency. Neural tube defects affect about 300,000 neonates, worldwide, according WHO (2).

Vitamins B9, vitamin B12 and iron are the most preferred and commonly used micronutrients to fortify flour although a range of other micronutrients such as zinc, vitamin A, thiamine, riboflavin, niacin, and pyridoxine may also be chosen.

Vitamin B9: Folic acid, is one of the most preferred micronutrients chosen for fortification as it is very compatible with flour and also helps eliminate neural tube defects. Fortification of flour with folic acid has been mandated in almost 78 countries, worldwide substantiating the importance and preventive action taken by the respective regions. A few studies (3) have even proven to be fruitful in decreasing the incidence of neural tube defects after consuming flour fortified with folic acid.

Iron: Flour fortified with iron can also potentially reduce the incidence of both iron deficiency and iron deficiency anaemia. Iron is required for the physical and mental development of children, and also improves the health of pregnant women.

Vitamin B12 (Cyanocobalamin): Vitamin B12 is ne- eded for healthy functioning of the body and supports by strengthening nerves, aiding in the synthesis of red blood cells, maintaining an effective immune system, and helping in normal pregnancy for women. Vitamin B12 deficiency causes an array of health concerns such as fatigue, breathlessness and memory loss. It is a vitamin that is not easily accessible to vegetarians and vegans as it is only prevalent in foods such as fish and meat. Hence, supplementary sources like fortified flour are essential to maintain required amounts in the body.

Stability of the micronutrients:

Vitamins are generally more sensitive to heat, light, oxidizing, and reducing agents as compared to minerals. Instability of micronutrients can be resolved by choosing the right forms of nutrients (i.e. stable salt forms, encapsulated forms). An optimum overage is considered in certain cases to nullify the loss of nutrients during processing and storage.

The physiochemical properties of the substrates may also affect the stability of the micronutrients. For instance, the moisture content of flour might affect the stability of minerals like iron and zinc. Hence, depending on the nature of the food (i.e. particle size, nutritional composition), the form of nutrients and their carrier are carefully chosen.

Dosing of the premix:

A premix is a blend of micronutrients in the optimum ratio to suit the nutritional claims of the standards approved by regulatory bodies around the world. A feeder and a blender are required to introduce the premix to the wheat flour. This continues to be a cost-effective technique.

The designed micronutrient premix is accurately metered through a volumetric feeder into the flour. These fee-

ders consist of a rotating feed screw which is driven by a motor, the speed of which can be adjusted to modify the rate of addition of the premix. These feeders either make use of gravity or a pneumatic system such as convection air to dispense the premix into the flour. In order to achieve uniform distribution of the fortificants in the flour, the feeders must be placed at a centralized location with respect to the conveyor carrying the flour.

A centrally-located feeder will ensure that there will be sufficient time provided for the fortificants to mix before the flour is collected and sent for packaging and storage. The plant should have the right mixers, feeders, and quality control equipment to ensure that the fortified flour has effective levels of the desired fortificants present in the finished product.

Addition of enzymes in wheat flour has several effects on the end products such as enhanced raising of the dough, aiding better texture and porosity and improved shelf life due to anti-staling properties.

Flour Improvers with micronutrients - A new concept

In addition to adding micronutrients – a conventional technique that is used to cut down the ill effects of malnutrition, the latest trend has been to combine the effectiveness of flour improvers and enzymes with the functional characteristics of micronutrient premixes – a blend of vitamins and minerals.

The physiochemical characteristics of wheat flour suits its baking applications and hence serves as the most preferred form of flour. Although its natural properties compliment various aspects required for baking, baking industries are opting for certain flour additives that have the tendency to alter specific properties of the flour. These alterations enhance the sensorial qualities of the end product (breads, cakes, buns, etc). The additives are defined as flour improvers. Commonly used flour improvers include enzymes. Addition of enzymes in wheat flour has several effects on the end products such as enhanced raising of the dough, aiding better texture and porosity and improved shelf life due to anti-staling properties.

Enzymes such as amylases play a pivotal role in improving the texture of the product. It breaks down complex sugar molecules into simple sugar units, enhancing the process of fermentation of the dough. In wheat flour, the main structural protein called gluten is the key molecule behind the elastic properties of the flour. Proteases are enzymes that break down the protein molecules such as gluten, altering the textural properties of wheat flour to obtain the desired textural character. Certain other enzymes such as lipase and asparginase are also added to improve the qualities of wheat flour.

The combination of enzymes and micronutrient premixes serves not only as a value addition to the nutritional profile but also refines the textural properties of the flour.

Conclusion:

Turkey is home to over 700 flour mills that produces over 12 million tons of flour every year, according to the Federation of Turkish Flour Industrialists (TUSAF). Turkey is one of the largest exporters of flour in the world and therefore serves as a central powerhouse to distribute fortified flour and help eradicate malnutrition in the world. Fortifying flour in Turkey can aid in curbing malnutrition in Central Asia and the Middle East since most of the flour is exported to these regions. These are also regions where the incidence of neural tube defects due to high degree of deficiency diseases are ubiquitous.

References

-(2)http://www.who.int/bulletin/volumes/94/1/14-151365/en/
-(3)https://www.cdc.gov/ncbddd/birthdefectscount/data.htm