Nutritional properties and health functionality of wholegrain millet sourdoughs

Thematic Area
Productivity Enhancing Technologies

Project Duration in Months
24 months

Country(ies) of Implementation
Nigeria

Problem Definition
In Nigeria, bread is consumed by many people daily. It is however relatively expensive because it is made from wheat that is not widely cultivated in the country. To cut the nation’s expense on wheat importation and find wider utilization for local substrates, Government mandated the use of 10% cassava flour for bread making. This does not solve the pecuniary problem as imported wheat forms 90% of the flour used. Nigeria is however blessed with many agricultural substrates with potential for use in baking. One of such substrates, millets are commonly grown in the country where they are processed into flour for making traditional thick and thin porridges, steam-cooked products like couscous, and non-alcoholic and alcoholic beverages. They have not been widely used in bread making because they lack the structure-forming protein, gluten, present only in wheat. However, the use of sourdough technique is known to improve the baking potential of non-wheat flours. In addition, foods made from wholegrain, non-wheat cereals are known to exert greater benefits beyond basic nutrition. The use of locally available substrates for bread making will help save on scarce foreign exchange resulting in economic benefits for the country. Development of novel products such as millet sourdoughs for making bread will increase the utilization of millets which are presently regarded as underutilised. Farmers, flour millers and bakers will benefit directly through improved livelihoods.

Objective
The objectives of the proposed project are to: 1. Increase the utilisation of indigenous substrates like millets in baked products especially bread by up to 100% for improved livelihoods among flour millers and bakers. 2. Increase productivity and millers’ income by up to 40% as demand for millet increases 3. Improve nutrition of average Nigerians at lower costs through the popularisation of wholegrain bread.

Methodology
Methodology 1. Collection, processing and analysis of wholegrain millet flours. Analysis will involve physico-chemical (particle size, falling number, proximate composition), visco-elastic (pasting properties by the Rapid Visco Analyser, cooked gel texture by the Texture Analyser. Primary parameters (hardness, cohesiveness, springiness and resilience) and secondary mechanical characteristics (gumminess and chewiness) will be calculated from the TPA graph). 2. Preparation of millet sourdoughs: Type I sourdough will be produced from wholegrain millet flours (equal amounts of flours weight/weight) at 30°C for 48 hours or until pH is approximately 4. Type I sourdoughs are traditional sourdoughs that are developed spontaneously by cereal microflora, and compare well with traditional African fermentations. 3. Sourdough characterisation: The millet sourdoughs produced will be analysed for total titratable acidity (TTA), pH, diacetyl and hydrogen peroxide. The microorganisms responsible for the sourdough fermentation will be enumerated from mature, dried sourdoughs. Lactic acid bacteria and yeasts, the usual fermenting organisms in sourdoughs, will be isolated on Mann Rogosa Sharpe medium (MRS) and Malt Extract Agar medium respectively. Characterisation of the isolated microorganisms will be based on conventional microbiological and molecular methods. 4. Sourdough breadmaking: Bread will be produced using 30 – 40% sourdough and wholegrain millet flours. Dough yield will be calculated after mixing all ingredients. A modification of the sponge and batter methods will be used. 5. Detailed nutritional analyses of sourdough bread samples including food composition, but with emphasis on nutrients with potential health benefits such as vitamins, amino acids, saturated and unsaturated fatty acids, dietary fibre and phyto-chemicals. 6. Sensory evaluation of the bread samples would be carried out to determine consumer acceptability of the sourdough bread. This would also involve evaluation of the willingness to pay and cost benefit ratio of the sourdough breads. 7. In vitro evaluation of probiotic potential of the bread samples would be carried out using Human Caco-2 cells, a model of mature cells of the small intestine, against three selected pathogens: Staphylococcus aureus, Salmonella typhimurium and enteropathogenic Escherichia coli. 8. In vivo evaluation of nutritional and health benefit of the bread samples would be carried out by studying the physiology of albino rats fed with diets containing high doses of the sourdough bread samples. Physical, chemical and biological examination of faecal samples from rats fed with bread diets will be comparatively analyzed with faecal samples of rats fed on normal diets, to determine the effect of prolonged dietary exposure on faecal bulk, distribution of gut flora and chemical composition of faeces. Physiological effects such as laxation, blood cholesterol attenuation and blood glucose attenuation would also be evaluated. 9. In vivo studies to substantiate the findings of in
vitro tests for the presence or otherwise of probiotic potential would be conducted by orally infecting experimental rats fed on sourdough bread with Salmonella typhimurium. 10. Data analyses: Data generated from the research would be subjected to two-way analysis of variance and means will be separated by Duncan’s multiple range tests or other appropriate tests; bivariate correlations will be used to determine correlations among comparable parameters as well as correlations between in vitro and in vivo studies.

Current State of Innovation
Early testing stage (Idea has evolved beyond an untested concept / blueprint)

Innovation Type
New product or service, New process which includes mechanism to deliver an existing product or service

Results and Potential Impact
Expected results include a procedure for wholegrain millet sourdough bread, potential starter cultures from indigenous millet sourdough microflora. As a result, there will be increased utilisation of indigenous millet varieties for bread making. The use of wholegrain sourdough technique will produce more nutritious, more flavour-intense and low-glycemic index bread. This is expected to transform the baking industry from a wheat importation-dependent one to a self-sustaining industry with up to 65% increase in earnings for bakeries and improved livelihoods for millet farmers.

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Potential Development Impact
The potential development impact of the project five years after funding ends include: 1. Innovativeness and flexibility in the Nigerian bread making industry with the use of locally available, indigenous substrates for bread making as it obtains in many countries globally. The use of 100% flour from local substrates will transform the industry 2. Poverty reduction by up to 40% among indigenous grain farmers as demand for local grains by flour mills increases 3. Sustainability in the baking and allied industries. Currently, Nigerian mills are fed with imported wheat in an unsustainable manner. Prices fluctuate and affect the economy of the millers and bakers in the country. The use of local agricultural substrates will bring about controllable supply, stability and sustainability outcomes of the project with relevant governmental agencies, they will buy into it by sponsoring workshops and trainings that will aim at sharing the use of wholegrain sourdough technique will produce more nutritious, more flavour-intense and low-glycemic index bread. This is expected to transform the baking industry from a wheat importation-dependent one to a self-sustaining industry with up to 65% increase in earnings for bakeries and improved livelihoods for millet farmers.

Growth Potential and Sustainability
The use and benefits of fermented wholegrain foods have been validated by a number of researchers for wheat, oats and some other cereals (Betoret et al, 2011). This project therefore holds great potential for scalability and replicability. In addition, there is a global increase in the demand for non-wheat or gluten-free foods and ingredients. This project can be replicated anywhere in the world using the standardized procedure that will be developed from the project seeks to demonstrate the feasibility in millets using the sourdough fermentation process. The Nigerian government recently increased tariff for imported wheat as part of its efforts to promote the substitution of wheat flour with 40% high quality cassava flour in bread. Moves such as these will drive the use of local and indigenous agricultural substrates for bakery products. It is therefore envisaged that the findings of this project will be useful in the near future. The use of wholegrain sourdough microflour will be a sustainable bread making strategy within the next five years. It is hoped that on sharing the findings and outcomes of the project with relevant governmental agencies, they will buy into it by sponsoring workshops and trainings that will aim at sharing the knowledge and also support pilot-plant trials. It is expected that government and local, state and national levels will help in organising farmers, millers and bakers associations for adoption of the project results. Organisational challenges may be basically that of fair selection, but once the stage is set for sequential execution, this should reduce or eliminate the challenge. Financial support from government will ease the burden of actualising the project outcomes. To ensure sustainability, the project design will commence with farmers for increased production, training in grain management and post-harvest storage followed by identification of small-holder farmers and food processors willing to receive training in sourdough bread making process. Master bakers will also be trained and volunteer bakeries will be selected for pilot demonstration and setting up of wholegrain sourdough baking lines.

Innovation
Developing new products for baking and extrusion technology, using millet sourdough from local and indigenous agricultural substrates

Organization Name (Co-Leader 1)
Federal University of Agriculture, Abeokuta

Position at Organization (Co-Leader 1)
Lecturer and Researcher

Unit within Organization (Co-Leader 1)
Department of Food Science and Technology

Organization Type (Co-Leader 1)
Academia or Research Organization

Organization Description (Co-Leader 1)
The Federal University of Agriculture, Abeokuta with the acronym UNAAB is one of the three Universities of Agriculture in Nigeria, the other being in Makurdi (Benue State) and Umudike(Abia State). It was established in January 1988. The University started at its mini-campus in Isale-Igbein right in the heart of
Abeokuta, the Capital of Ogun State. The University moved in December 1997 to its permanent site, a 10,000-hectare Campus which is located next to the Ogun-Oshun River Basin Development Authority on the Abeokuta-Ibadan road in the North Eastern end of the city, 15 km from Abeokuta City Centre. The establishment of the Universities of Agriculture was an entirely new concept for promoting agricultural education and services for agricultural development and attainment of self-sufficiency in food and fibre in Nigeria. The University has a total of 179 academic programmes made up of 44 undergraduate programmes, 135 graduate programmes which include 22 Post graduate diploma programmes, 57 Masters degree programmes and 56 Doctorate degree programmes. The University has following colleges: College of Agricultural Management and Rural Development - COLAMRUD; College of Animal Science and Livestock Production - COLANIM; College of Plant Science and Crop Production - COLPLANT; College of Environmental Resources Management - COLERM; College of Natural Sciences - COLNAS; College of Veterinary Medicine - COLVET; College of Engineering - COLENG; College of Food Science and Human Ecology-COLFHEC; Postgraduate School. Within its short life, it has come to be rated as one of the best Universities in Nigeria. In the maiden and second Universities Research Fair organized by the National Universities Commission in Nigeria, the Federal University of Agriculture, Abeokuta was rated in the first position as the best research University in Nigeria in 2004 and 2005.

Team Description (Co-Leader 1)
The Nigerian Project Team comprises of young scientists and researchers, Adewale Olusegun OBADINA (Food Scientist and Food Microbiologist), Mojisola Olayinka Edema (Food Microbiologist) and Abdul Rasag Adebawole (Food Engineer) all with PhD degree. Dr A.O. Obadina will be the Project Coordinator (PC). Dr Obadina is a young researcher but with experience in project management. He has been involved in execution of multigorganisational projects for the United Kingdoms Department for International Development and other agencies. These researchers have over 5 years experience in fermentation of traditional foods from cereals, roots and tubers and adequate experience in food quality and safety. They also have a good peer-reviewed publication record with organizational, planning and budget management experience at the researcher level. The team core competencies include: ability to work as a member of a multi-disciplinary team in a cross-cultural environment, excellent interpersonal, and team building skills, good statistical data analysis capabilities, fluency in oral and written English.

Organization Name (Co-Leader 2)
Embrapa (The Brazilian Agricultural Research Corporation)

Position at Organization (Co-Leader 2)
Researcher

Unit within Organization (Co-Leader 2)
Embrapa Food Technology

Organization Type (Co-Leader 2)
Academia or Research Organization

Organization Description (Co-Leader 2)
The Embrapa Food originated from the merger of three existing institutions in Rio de Janeiro with a long tradition of research: the Institute of Food Technology, Institute of Oil and Beverage Technology and Institute of Fermentation Technology. In 1971, as a result of this merger, it was created the Center for Agricultural and Food Technology - CTAA. In 1973, it was created Embrapa, and the CTAA was been incorporated into this institution as one of its Decentralized Units. In 1984, the CTAA was transferred to new facilities, built in the neighborhood of Guaratiba, when it took also nationwide and had its name changed to National Research Center of Food Agroindustrial Technology. At the end of the nineties, with the implementation of the communication policy of Embrapa, the CTAA started to adopt the name synthesis Embrapa Food Technology. The Embrapa Food Technology is one of 55 Research or Administrative Centres of Embrapa System. Embrapa Food Technology coordinates the research and development actions of products and services demanded by agribusiness. It also studies technology solutions for developing products, processes and services that result in increased competitiveness and social equity, quality improvement and cost reduction in different production chains that make up the agribusiness in order to ensure food safety for consumers. Embrapa Food Technology has been conducting the transference of products, processes and services developed in partnership with other research organizations.

Team Description (Co-Leader 2)
The researchers are, Antonio Gomes Soares, Marcos Jose de Oliveira Fonseca, Murillo Freire Junior, Carlos Wanderlei Piler de Carvalho, Cristina Takeite from Embrapa Food Technology. The researchers from Embrapa Food Technology develop innovative researches in the following areas: juice processing, technology and extruded cereal products, postharvest technology of fruits and vegetables, vegetable oils technologies and food quality analysis. The researchers from Embrapa Food Technology have the Ph.D degree. The researchers in the postharvest of fruit and vegetables include studies of plant physiology, respiration rate, studies with controlled and modified atmosphere for fruits and vegetables and development of edible coatings for fruits and vegetables. The researches on cereal technology involve the development of new products for bread making, extruded products and edible films from cassava flour.

Key Bibliography

Budget

Environmental, Social and Legal Compliance Statement

I hereby attest to the best of my knowledge that all environment and social safeguards will be in place regarding potential negative environment and social impacts of the project including any potential impacts on indigenous people. I also attest the project will comply with the specific legislation in both countries including but not limited to those related to germplasm exchange, testing involving human subjects, use of biotechnologies, and intellectual property.

Budget

Total: 0

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