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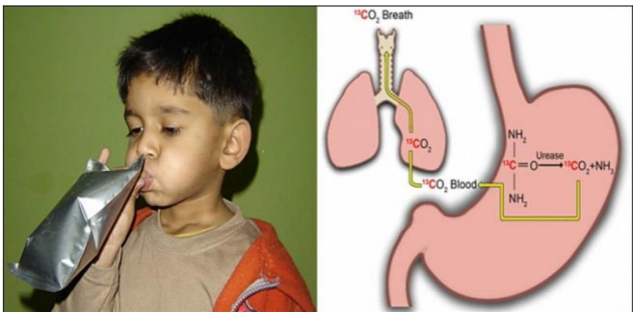
ISOTOPE TECHNIQUES TO HELP UNDERSTAND LINKS BETWEEN DISEASE AND CHILD GROWTH

同位素技術幫助了解疾病和兒童生長間的關聯性



Deploying stable isotopes to assess a condition contributing to growth failure in children has a potential to improve our understanding of what Environmental Enteric Dysfunction (EED) is and how it can be combatted, two recent scientific reviews co-authored by IAEA experts have highlighted.

The reviews were published in the world-renowned journals Pediatrics (November 2016) and the Journal of Pediatrics Gastroenterology and Nutrition (September 2016).

"EED is an important public health problem that limits child growth and future adult potential," said Cornelia Loechl, Head of the Nutrition Section at the IAEA and a co-author of the two papers. "Development of accurate,

報告摘要(KEY INFORMATION)

1. 原子能總署與專家在最近合作撰寫的兩篇科學評論中指出，使用穩定同位素可以用來評估導致兒童生長障礙的病症，並有助於理解環境腸功能紊亂（EED）造成的原因。
2. 在原子能總署和聯合國糧食及農業組織的支持下，伊拉克開發新的耐旱小麥品種的產量增加了四倍。目前這個突變品種占到該國產量的近三分之二。
3. 歸功於核技術，二十年前的秋天，坦桑尼亞沿海的一個島嶼成為第一個在非洲因核技術而擺脫采采蠅的島。在根除之前，由於采采蠅造成家畜的疾病，每年為農民造成 200 萬美元的損失。
4. 根據聯合國糧食及農業組織的估計，世界上約有 7.95 億人營養不良，其中大多數人生活在農村地區依靠農業生存，因此原子能總署特標定世界糧食日
5. 在原子能總署技術合作支持下，加強了摩洛哥國家獸醫實驗室檢測獸藥殘留和動物疾病的能力。

field-based non-invasive methods to diagnose the condition is urgently needed and stable isotope techniques offer the advantage that they can be used to assess multiple aspects of EED."

EED is an inflammatory disorder of the gut primarily resulting from recurring infection in the small intestine, causing incomplete absorption and ineffective use of nutrients. It also weakens the immune system, and can undermine the effectiveness of oral vaccines (see What is EED?). Children are particularly susceptible, and EED often contributes to poor child growth, which results in reduced cognitive development and reduced economic productivity later on in life.

The two scientific reviews are the result of an experts' meeting hosted by the IAEA in 2015 to discuss the link between EED and growth failure in children. The papers propose mechanisms for the interaction between the condition and child growth and how the problem can be treated. They also explain how stable isotopes offer a gateway to a better understanding of the condition and how to tackle it.

Current techniques to measure EED in children, such as the sampling of intestinal tissue by biopsy, are cumbersome, invasive, expensive and as a result often not carried out, Loechl explained. "The use of non-radioactive stable isotopes to non-invasively track EED was favourably proposed as an efficient alternative to those techniques because of their versatility."

Stable isotopes can be used to study how the stomach and intestinal system work and track individual nutrients – including proteins, fat, carbohydrates, minerals and vitamins – and bacterial cells to help understand how these are affected by EED. These techniques can also be used to measure health implications of EED on body composition and energy partitioning. Carbon 13, for example, can be used to label nutrients and track their digestion and absorption by the body. Deuterium oxide, a stable isotope of hydrogen, can be used to measure lean or fat mass accumulation, to track synthesis of protein and fatty acids and study the function of individual bacterial cells.

Treatment of EED should include provision of essential nutrients, improving hygiene and sanitation and promotion of the growth of beneficial bacteria in the intestine.

THE SCIENCE

What is EED?

EED is a modification in intestinal function that seems to present in multiple ways that can be measured separately:

Key among these is that the intestine walls become unusually leaky/porous and the shape of the tissues lining of the intestines are altered, becoming less fit to absorb food nutrients and to prevent bacterial cells from passing.

Inflammation is another major manifestation in EED and is a natural response by the body to external invasion.

Limited nutrient passage or leakages combined with uncontrolled bacterial cell movement form

a complex phenomenon that is thought to limit growth. Growth in children is driven by the growth hormone (GH) which acts like a catalyst to trigger the addition of one block – referred to as growth plate – to another to ensure linear bone growth from birth to puberty and sometimes beyond. Any process that limits production or the function of GH leads to linear growth retardation, a condition that is commonly referred to as stunting. EED related stress leads to reduced expression of GH receptor in the liver, meaning that GH signalling is inhibited.

The entirety of the microbial population in the digestive tract is called the microbiome. The microbiome is fundamental to human host function, immunity and survival. Stress conditions seen in EED result in microbiome immaturity and replacement of beneficial bacteria with harmful ones. This propagates infection that further adversely affects nutrient utilisation and growth.

To fully understand the mechanisms underpinning growth retardation in EED and to design interventions to prevent and treat it, sensitive techniques for diagnosis and classification need to be developed for use in the field. Using nuclear techniques will be a good addition in this endeavour.

IRAQ USES NUCLEAR TECHNOLOGY TO IMPROVE CROP PRODUCTIVITY AND ADAPT TO CLIMATE CHANGE

伊拉克使用核技術提高作物生產力和適應氣候變化

A new drought-tolerant wheat variety developed in Iraq with the support of the IAEA and the Food and Agriculture Organization of the United Nations (FAO) has increased yields four-fold. This mutant variety now accounts for close to two thirds of all the wheat produced in the country.

Iraq is increasingly making use of nuclear technology to improve its crop yields and cope with challenges brought about by a changing climate. Researchers in Iraq have developed new drought-tolerant plant varieties and improved water and soil management.

These developments have helped enhance food production and adapt to climate change, said Ibrahim Bakri Abdulrazzaq, Director General of

Baghdad's Agricultural Research Institute at Iraq's Ministry of Science and Technology. "We have developed efficient packages of technology that aim to overcome the most pressing problems in the area of agriculture."

Iraq's rangelands, where shepherds herd their sheep and cattle, have seen warmer temperatures and less rainfall since the early 2000s. Without a vegetative cover, they have become less fertile and more susceptible to erosion, affecting the country's rain-fed agriculture and the wheat-producing provinces, Abdulrazzaq explained.

From 2007 to 2011, Abdulrazzaq and his colleagues worked alongside experts from the IAEA and FAO to find solutions to these challenges through mutation-induced plant breeding. This technique involves exposing plant seeds and cuttings to radiation to generate genetic variability and then select the improved agronomic traits of interest.

Iraqi scientists used the technique to develop four improved varieties of traditional crops that tolerated both drought and salty soil, soil conditions typical of dry areas that hinder plant growth. The varieties are also resistant to lodging — when stems or roots are displaced from their vertical and proper placement — and seed shattering, both major causes of yield loss in crops.

"All the results have gone directly to the farmers. Now, the farmers tell us they want the new plants," Abdulrazzaq said. "They are even ready to pay more because they know the wheat and the barley are salt-tolerant, drought-tolerant and have high productivity."

Whereas the conventional variety of Iraqi wheat only produces one tonne per hectare, the new variety developed through mutation breeding boasts a productivity of four tonnes per hectare. Almost 65% of the wheat produced in Iraq today comes from these new varieties.

These new varieties are also more resistant to dust storms – another problem farmers increasingly face. "Some years ago, we had 17 dust storms per year," Abdulrazzaq said. "Now, partly because of the unprotected rangelands, we have more than a hundred dust storms. And this affects the fertility of the soil, water resources and human beings."

More than food

Iraq has also collaborated with the IAEA in applying nuclear technology in other fields, such as nuclear medicine, radiotherapy and industry, including the construction of oil pipes using non-destructive testing methods. Equally important is the decommissioning and environmental remediation of Iraq's nuclear complex destroyed in 2003.

Since 2006, the IAEA has been working with Iraqi officials to reduce the radiological risk to the public and the environment by decommissioning old installations and remediating decontaminated areas and disposal sites.

"The project is a big undertaking," said Eric Howell, Managing Director of the environmental risk assessment company Facilia Projects participating in the project. "It touches on all the relevant fields you could think of: from regulatory support, radiation safety to radioactive waste management. The IAEA has played an integral role in coordinating the decommissioning work in the country."

Iraqi and IAEA experts discussed these and other areas of technical cooperation during a recent meeting held in Vienna to chart a new plan of enhanced collaboration, said Abdulghani Shakhashiro, Programme Management Officer at the IAEA.

Meanwhile, scientists and researchers like Abdulrazzaq are working to help Iraq move a step closer to the sustainable development goals. "Sometimes, Iraq gets forgotten. But with more involved stakeholders and an improved security situation, the story can always change," Howell said.

TSETSE FREE FOR 20 YEARS THANKS TO A NUCLEAR TECHNIQUE: THE ISLAND OF UNGUJA, ZANZIBAR

歸功於核技術，Island of Unguja, Zanzibar 擺脫采采蠅 20 年

Twenty years ago this autumn, an island off the coast of Tanzania became the first in Africa to get rid of the tsetse fly thanks to a nuclear technique. Prior to eradication, losses to livestock due to the nagana disease the flies carried used to cost farmers on Unguja Island, the largest in the Zanzibar archipelago, US$ 2 million a year.

“The removal of the tsetse fly and nagana from the Unguja island has been one of the most important achievements to enhance agriculture and improve the livelihoods of farmers in Unguja in the last 20 years,” said Khalfan Saleh of the Ministry of Agriculture, who oversaw the national eradication campaign.

The nuclear based sterile insect technique (SIT) played a key role in achieving the complete eradication of the tsetse fly Glossina austeni population, and reducing the prevalence of nagana from 19% to zero. (See Scientific birth control for flies)

The 20th anniversary of the last wild tsetse fly being trapped on the Island was marked in September 2016. Since 1996, Unguja Island has been free from this large blood-sucking fly and from 1997 there has been no evidence of the presence of the parasites that cause nagana in livestock.

"The elimination of nagana has resulted in a reduction in abortion rates in cattle, calf mortality and an increase in meat and milk production as well as an increase in numbers of crossbred cows," Saleh said.

Nagana is a debilitating chronic condition in livestock that reduces fertility, weight gain, impacts meat and milk production, and makes livestock too weak to be used for ploughing or transport, which in turn affects crop production, Saleh highlighted. It is a wasting disease in cattle, caused by a parasite that is transmitted when the tsetse flies bite animals to feed on their blood.

Tracking progress

The Tanzanian and Zanzibar governments, supported by the IAEA and the United Nations' Food and Agriculture Organization (FAO), implemented the SIT programme between 1994 and 1997.

In the initial stages of the project, the tsetse population was reduced by treating cattle with an insecticidal 'pour-on' application and using cloth targets, soaked with insecticides that attracted and killed the tsetse flies upon contact.

After the tsetse population was suppressed, weekly aerial releases of up to 100 000 sterile male tsetse flies were made to reduce the reproductive capacity of the native tsetse fly population so as to eventually bring about the elimination of both the tsetse fly population and tsetse-transmitted nagana from the Island.

To assess the impact of the SIT strategy, periodic socio-economic surveys (in 1999, 2002, 2014 and 2015) involving deployment of tsetse traps and screening of cattle nagana infections, were carried out. These confirmed the absence of both tsetse flies and nagana on the island.

Socio-economic studies in 2014 found that the total number of improved (crossbred) cattle breeds had increased by 38%.

Milk production increased following eradication of tsetse and nagana and data from the 2014 socio-economic survey found that crossbred cattle breeds were producing an average of 9.7 litres of milk per cow per day compared to 4.6 litres produced by indigenous cows.

Finding a solution over the years to the havoc created by tsetse flies to livestock has been a major challenge to the combined scientific efforts of the IAEA and the FAO, said Jorge Hendrichs, Head of the Insect Pest Control Section at the Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture.

Scientific birth control for flies

SIT is a form of insect pest control that uses ionizing radiation to sterilize male tsetse flies that are mass-produced in special rearing facilities. The sterile males are released systematically from the ground or by air in tsetse-infested areas, where they mate with wild females, which do not subsequently produce offspring. As a result, this technique can eventually eradicate populations of wild flies. The SIT is among the most environmentally friendly control tactics available, and is usually

applied as the final component of an integrated campaign to remove insect populations.

GOING CLIMATE-SMART: IAEA MARKS WORLD FOOD DAY

走向智能氣候：原子能總署標記世界糧食日

'The climate is changing. Food and agriculture must too'. This is the global message for World Food Day 2016. Almost 795 million people in the world are undernourished, according to estimates from the Food and Agriculture Organization of the United Nations (FAO). Out of these, the majority live in rural areas and rely on agriculture for their food and income.

Demand for food will only grow as the world population is expected to exceed 9 billion by 2050. At the same time, higher temperatures and more frequent environmental disasters put pressure on agriculture and food systems, which must, in turn, be adapted to deal with the adverse effects of climate change and become more resilient, productive and sustainable.

To address this challenge, the IAEA, in partnership with FAO, is supporting countries in using climate-smart agricultural practices to prevent projected global food shortages. Through their joint Programme on Nuclear Techniques in Food and Agriculture, the two organizations assist countries in improving their agricultural practices with nuclear and related technologies to adapt to climate change while still producing more food and protecting natural resources.

This article summarizes the impact of several recent projects in this area.

Stronger crops

Nuclear science helps farmers around the world boost their produce as changes in climate make it difficult for traditional varieties to grow. In Iraq, for example, warmer temperatures and less rainfall since the early 2000s have made the land more susceptible to erosion, affecting the country's rain-fed agriculture and the wheat-producing provinces.

With the help of experts from the Joint FAO/IAEA Division, scientists in the country have found solutions to these challenges through mutation-induced plant breeding. This technique involves exposing plant seeds and cuttings to radiation to induce natural genetic variability and then select the improved traits of interest.

As a result, Iraqi scientists have developed four improved varieties of traditional crops that tolerate both drought and salty soil — typical

soil conditions in dry areas that hinder plant growth. Almost 65% of the wheat produced in Iraq today comes from these new varieties. Read more about plant breeding in Iraq and how it is making a difference or watch how mutation breeding works.

Moving women farmers out of poverty

Agriculture is the primary source of income and livelihood for up to 80% of Sudan's population. But due to shortages in water supplies caused in part by warming temperatures and climate change, growing food crops is difficult.

Thanks to a drip irrigation project that started in 2015, women farmers in Kassala, eastern Sudan, are now growing vegetables using climate-smart agricultural methods. Local scientists worked with experts from the Joint FAO/IAEA Division to use nuclear science to optimize water and fertilize use through drip irrigation. They then helped to set up these irrigation systems and train the local woman in how to use them. Now the women run their own small-scale farms and home gardens to feed their families, their neighbours and their wallets. Read more about how hundreds of women are now benefiting from this, or watch this animation.

Healthy animals, healthy food

Millions of people depend on livestock for food and income, but diseases kill many animals and can spread to neighbouring farms and countries. Animal diseases are also more likely to emerge as climate conditions become more favourable for diseases to spread and for disease-carrying insects to breed. To prevent this, veterinary personnel can use nuclear-derived techniques to help detect and contain outbreaks.

In Botswana, thanks to the support of the IAEA and the FAO, scientists now have the tools they need to quickly and effectively diagnose animal diseases to prevent their spread. These nuclear-derived techniques have proven essential for helping the country to remain mostly free from dangerous animal diseases. This has allowed Botswana's beef industry to continue to grow and export to other countries, while also protecting local farmers who rely on livestock for food and income. Read more about how Botswana is successfully controlling animal diseases.

Saving the orange

In some regions, climate change brings warmer and moister conditions, which are often a breeding ground for insect pests. Many insects that previously could not survive in certain regions can now tolerate these areas due to raising temperatures, which creates a problem for farmers and their crops. Insect pests can cause farmers to lose millions of dollars when the insects attack crops. This was the case in South Africa until they started using the sterile insect technique.

By 2005, a pest called the false coddling moth had spread rapidly in parts of South Africa, bringing the citrus industry to the brink of extinction. A nuclear technique designed to control and shrink the insect population helped the multi-billion dollar industry protect its products and rebuild. Read more about how the

Western Cape turned its fate around or watch how the sterile insect technique (SIT) works.

Addressing the issue at its heart

Agriculture contributes to over 20% of the global release of greenhouse gas emissions caused by human activity. Increased amounts of greenhouse gases in the atmosphere cause global warming, which drives climate change. To help chart out ways to reduce these emissions, and in turn combat climate change, scientists are using isotopic techniques to understand and develop more climate-smart agricultural practices.

Soil and environmental conditions and farm management practices each have an impact on the amount of greenhouse gas emissions coming from agriculture. Scientists from around the world are working together through projects supported by the Joint FAO/IAEA Division to collect data on how these different factors interact. By finding ways to strike a balance in how fertilizer, water and soil are used with agricultural crops, scientists aim to develop scientifically-based guidelines countries can use to reduce greenhouse gas emissions and deal with climate change. Read more about how they are working to strike this balance and how nuclear techniques make a difference.

WORKING TOWARDS FOOD SAFETY AND ANIMAL HEALTH IN MOROCCO

努力實現摩洛哥的糧食安全和動物健康

An IAEA technical cooperation project[1] supported by the Joint FAO/IAEA Division of Nuclear Techniques in Food and Agriculture, has greatly enhanced the capacities of Morocco's national veterinary laboratories to detect veterinary drug residues and animal diseases. The project, initiated in January 2014 at the request of the government of Morocco, was designed to support the work of Morocco's National Office for Food Safety (ONSSA).

Morocco's geographical location right at the crossroad between the Mediterranean and Central Africa exposes the country to a higher risk of the introduction of animal diseases. These can threaten animal health, meat production capacity and the country's ability to export meat products, as well as public health (considering zoonotic diseases). Morocco urgently needed to be able to detect infectious animal diseases such as foot-and-mouth disease,

bluetongue, African horse sickness and African swine fever, rapidly, including diseases with zoonotic potential such as brucellosis, tuberculosis, rabies and others. Veterinary drugs and other agrochemicals are needed to control these diseases. However, since residues of these chemicals may end up in animal products, laboratory analytical capabilities to monitor the residues and assure consumers were equally urgently required.

ONSSA was established in 2010 to support the goals of the Morocco Green Plan (Plan Maroc Vert, PMV), an agricultural strategy introduced in 2008 to combat poverty and hunger by improving national agricultural performance and output. ONSSA is responsible for national regulatory matters related to food quality and safety, as well as animal and plant health. Recent investments by the ONSSA in veterinary laboratories have aimed to enable better control of food products under the Moroccan Veterinary Drug Residue Monitoring Plan (VDRMP), which was also established under the PMV.

Although the Moroccan veterinary laboratories were equipped with real time polymerase chain reaction equipment used to detect and analyse specific pathogens' RNA or DNA, local staff needed suitable training in order to make maximum use of the high tech equipment available. In addition, the speed at which technologies were evolving (enabling shortening of detection time, essential for early and rapid detecting of infectious diseases), meant that personnel required training in state-of-the-art diagnostic and detection techniques. This would make it possible to significantly shorten analytical times, and increase the number and types of diseases detected. The same is applicable in the food safety area. Immediate Agency support was required for human resource development.

Through the IAEA technical cooperation project, support was provided to ensure the effective use of relevant analytical and diagnostic equipment. Laboratory personnel were trained (with the ability to train others) in veterinary drug residue testing and animal disease detection. Capacities in early detection and response to outbreaks such as avian influenza, rabies and others were also significantly strengthened.

As a result of the project, staff at the veterinary laboratories can now identify ten types of veterinary drug residues using isotope based liquid chromatography-mass spectrometry (an increase from the three types that could be detected prior to the start of the project). This means that the laboratories can cover the whole range of residues including restricted substances. The liquid chromatography-mass spectrometry technique separates and detects chemicals in other substances, making it essential for residue detection and "fingerprinting"[2]. The number of accredited drug residue and animal disease detection methods used in Morocco according to the ISO 17025 standard[3] has more than doubled since 2012.

Today, the Moroccan government is able to better implement its national drug residue monitoring plan using high level analytical

standards that meet international guidelines and those of major trade partners. This has enhanced food safety levels in the Moroccan market and will support plans to export poultry products.

In the field of animal health, the awareness of laboratory analysts regarding quality assurance and quality control in molecular biology analysis was greatly improved. The analysts participated in the diagnosis of the first outbreak of H9N2[4] in Morocco in early 2016.

Overall, the project has strengthened networking between laboratories, both in Morocco and internationally, that are working on chemical contaminant analysis and molecular biology diagnosis. In the long run it will contribute greatly to the country's agricultural export possibilities, and will improve food safety and animal health.