沙漠研究 **19**-1, 375- 378 (2009 ) "Desert Technology IX "
Journal of Arid Land Studies Refereed Paper

# Advanced Processing of Useful Food Material for the Establishment of a Regional Development Model in Arid Areas

Kenichi KASHIWAGI[1], Hiroko ISODA[1], Junkyu HAN[1], Mitsuteru IRIE[1],
Hiroshi NABETANI[2], Mitsutoshi NAKAJIMA[1]

**Abstract:** As it faces growing international competitiveness, one of the main challenges for the agro-food sector in North Africa is to enhance its productivity and level of technology. By applying the 'Bioassay Screening System' method, various biological activities were detected in the components of Tunisian olive and aromatic plants, including anti-oxidation, anti-pathogens and anti-inflammation. The scientific detection of biological activities provides the potential to increase the value-added of traditional products, and it can also be applied to functional foods and cosmetics as well as medicines for the development of a new 'market of functional foods'. The introduction of advanced technology for food processing and efficient distribution to those useful bio-resources would add another value, and would open the door to a new stage of rural and regional development. Such development, based on ideas and knowledge inspired by traditional bioresources, would not only provide a new way to increase the competitiveness of local industries, but also would contribute to job creation and stabilization of the regional economy. The purpose of this paper is to conceptualize and propose a basic model of regional development, which takes a systematic approach to the use of locally available food material and integrating several approaches, such as the detection of biological activities, advanced processing, an efficient distribution system and the effective use of bio-resources.

**Keywords:** Bioassay screening system, Effective use of useful bio-resources, Efficient distribution, Food processing, Regional development

## 1. Introduction

Economic integration with the world market is almost inevitable for North Africa as a consequence of having concluded the Association Agreement under the framework of the Euro-Mediterranean Partnership (Barcelona Process), and of the increasing discipline with respect to free trade in the process of multi- and bilateral trade negotiations[A)]. In the face of growing international competitiveness, one of the main challenges for the agro-food sector in North Africa is the enhancement of productivity and the level of technology. However, most historical experience suggests that development and expansion based upon endowed factor of production, namely the accumulation of capital which is mostly transformed by natural resources, eventually results in diminishing returns to scale in the economy. This paper proposes an alternative idea that attempts to transit to the increasing returns of the economy, in particular with agro-food sector in North Africa, by introducing the notion that an 'idea' is a main source of growth and that 'knowledge' is a substantial factor of production. This approach integrates the scientific detection of biological activities in locally available bio-resources with an advanced processing, an efficient distribution and an effective use of bio-resources. This integrated approach could provide the key to a sustainable path for regional development. Hence, the purpose of this paper is to conceptualize and propose a basic model of regional development in North Africa, in particular, by developing a systematic approach through the use of locally available food materials in arid areas.

## 2. Integrated Approach

It is widely recognized that the traditional approach to the development of the agro-food sector is resource-based. Its development depends upon the improvement of the productivity of land and labor. The history of agricultural development suggests that one of the traditional innovations is designing a farming system for more intensive cropping without causing depletion in soil fertility. The 'Agricultural Revolution', observed in Europe from the seventeenth to the end of the nineteenth century, is a typical example based on the recycling

[1] Alliance for Research on North Africa (ARENA), University of Tsukuba, Tsukuba, Ibaraki 305-8572, Japan
[2] National Food Research Institute (NFRI) / National Agriculture and Food Research Organization (NARO), Tsukuba, Ibaraki 305-8642, Japan

of plant nutrients and the crop-rotation system. However, science-based agriculture is another approach, where progress is achieved by introducing the application of chemical fertilizer and improvements in crop varieties. The 'Green Revolution' in tropical Asia between the 1940s and the 1960s introduced significant innovations in productivity based upon scientific knowledge and improved the yields of crop varieties, i.e. high-yielding varieties. Yet, both these approaches depend upon improving the productivity of land and labor.

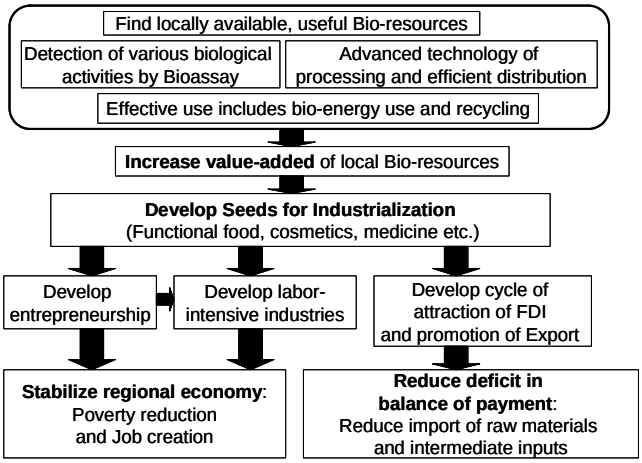



**Fig. 1. Integrated Approach to Regional Development.**

In contrast, the approach described in **Figure 1** is different from the traditional one. It has four main functions. First, this approach starts by finding potential bio-resources. Second, various biological activities are detected in the locally available bio-resources with the 'Bioassay Screening System'. Third, the advanced processing of micro- and nanotechnologies, for instance 'emulsification', are introduced into the processing of the bio-resources. Fourth, the effective use of bio-resources, including use for energy and recycling is also considered. The introduction of efficient distribution and marketing will develop a new market that emerged by the detection of biological activities and food processing. It should be noted that this approach depends mainly upon locally available factors of production. The only external factor introduced will be scientific knowledge. With a combination of a more efficient system of distribution and the use of recycling, such as the use of olive oil residue, the seeds of industrialization will open the door to a new stage of rural and regional development. This new stage does not depend upon the improvement of either labour or land productivity; it depends upon improving the quality of the products by increasing the value added. Such an integrated approach not only has the potential to improve the added value of traditional plants, but also has the potential to develop a new market of functional foods, cosmetics and medicines.

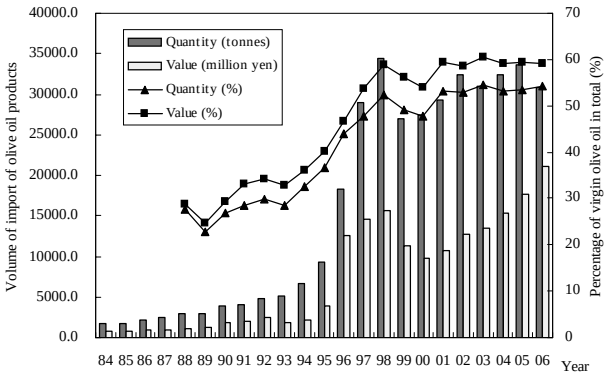
This integrated approach will have three effects on regional development. First, ideas inspired by local products promote entrepreneurship. By depending less upon the import of raw materials, intermediate and capital inputs, the only new factors to be imported in the process of production are new ideas and knowledge. Second, the development of region-based industries using locally available resources contributes to job creation, to the development of labor intensive industries and to reducing out-migration and urban unemployment. Third, the development of the seeds of industrialization will attract foreign direct investment (FDI). The dynamic effect, i.e. the cycle of the attraction of FDI and the promotion of exports, is the key to development. In addition, development based on local products that incorporate new ideas and knowledge will result in a reduction in the imports of raw material, thus reducing the intermediate inputs produced domestically. Development based upon ideas and knowledge inspired by traditional bio-resources could provide a new way to increase the competitiveness of local industries. Furthermore, the promotion of the local industry could contribute to job creation and to the stabilization of the regional economy.

Development economists consider 'ideas' as a source of growth and 'knowledge' as a factor of production that makes it possible to avoid the diminishing returns to scale of the economy. To induce increasing returns to scale, economists emphasize the importance of developing the production of knowledge[B)]. In the next section, above-described integrated approach was applied to the regional development in Tunisia by considering olives and olive oil as one of the 'seeds for industrialization'.

## 3. Regional Development

The production of olives and olive oil in North Africa is an industry that has the potential for both production and job creation. The promotion or export of olive oil is an important strategy for regional and national development in order to catch up with industrialized regions such as the European Union. Olives and

olive oils in North Africa and Mediterranean countries, on the one hand, are traditionally known for their high quality and long shelf life. On the other hand, Japan is a potential emerging market for olive oil. Reflecting an increase in the demand for health and better nutrition, olive oil consumption in Japan has shown an increasing trend in the last two decades. According to the statistics of the Japan Tariff Association, Japan has an annual consumption of around 30,000 tonnes (Japan Tariff Association, 2007). However, almost 99% of imports are from traditional olive oil producing and exporting countries, such as Spain and Italy. Exports for instance from Tunisia and Morocco are negligible, but producers have an interest in reinforcing and increasing their penetration of the Japanese market.




(Note) The value is based upon the CIF value. "The virgin olive oil" is defined as virgin olive which isnot chemically modified.
(Source) Japan Tariff Association, *Japan Exports & Imports, commodity by Country*, various editions.

**Fig. 2. Volume of Import of Olive Oil Products in Japan, 1984-2006.**

Bioassay screening systems have detected many medically effective biological activities, such as reduction of atopic dermatitis, anti-allergy, anti-oxidant, anti-pathogenic and anti-inflammatory properties, in the components of Tunisian olive and aromatic plants (Isoda, 2008). Recent scientific research has revealed that Tunisian olives and olive oil contain various physiologically active compounds (Abaza *et al*., 2007; Kawano *et al*., 2007; Yamada *et al*., 2008). Their activities include, for instance, anti-oxidants (hydroxytyrosol, tyrosol and oleuropein), anti-allergic substances (luteolin and apigenin) and molecules (oleuropein and apigenin-7 -O-glucoside) that stimulate the transition of cancer cells into normal (differentiated) cells. Bioassay methods also detected the protective effects of olive leaf extracts against human leukaemia and the anti-melanogenesis. It is interesting to note that stress tolerance, particularly in dry conditions, may have an effect on the development of such useful properties. By scientifically detecting biological activities, traditional products gain the potential to increase their added value, both by being applied to functional foods and cosmetics, and by medicinal use for the development of a new 'market of functional foods'.

Regarding the food processing, we regard that the new technology of microchannel (MC) emulsification for the production of foods would be a new development which makes it possible to process raw materials into valuable products. The droplet generation process, by MCs, is possible to be applied to olive oil produced in Tunisia for emulsions of olive oil-in-water. Such new technologies are expected to contribute to better nutrition intake to improve health and diet, and they are expected to make the production processes of food more sustainable. Such food engineering research intended to add further value to indigenous bio-resources in which new functions were detected.

As for the effective use of bioresources, some resources for bioethanol production, such as cassava and rice, can be used as food. As an alternative, the exploitation of wild grass as well as cellulose ethanol is also possible to consider as an energy resource that does not compete with food supplies. By implementing a Life Cycle Assessment (LCA) of $CO_2$ emission and estimating the volume of ethanol produced in biomass power generation, those plants can also be considered an available resource for energy. For biodiesel fuel production, the use of inedible lipids would be more sustainable materials. These include used edible oil, lipids contained in waste effluent from oil milling process and by-products from oil refining process. Crude oils from industrial crops such as *Jatropha* may also be promising materials for biodiesel fuel. The importance of examining the balance of energy input and $CO_2$ emission for bio-energy production is suggested, including harvest, transport, process and feedstock, and that biofuels will demand more energy than they produce.

With respect to technological transfer, one might consider that the technological gap lines between advanced knowledge such as bioassay, food processing, bioenergy production developed in Japan and the level of local technology for instance in Tunisia. However, it should be noted that extracts and compounds of crops and plants in which new biological activities were detected are locally available and indigenous to North Africa.

The only external factor is idea and knowledge concerning new biological activities of useful bioresources. Thus, it takes huge cost in the stage of 'invention' in particular and for localizing the advanced technology to develop economically feasible technology. Yet, once biological activities were detected, those new functions themselves are expected to become public goods in the stage of 'imitation and diffusion'. The usefulness themselves, as public goods, have two distinct characteristics i.e. non-rivalry and non-excludability. From the point of cost-effectiveness, idea and knowledge obtained can be used continuously without additional costs. In addition, business-academia collaborative research on intellectual property right also contributes to reduce cost for transfer and localization of the advanced techniques and provide incentives for local entrepreneurs.

## 4. Conclusions

This paper conceptualized a basic model of regional development based upon bio-resources, for arid areas in particular, and proposed an integrated approach by using locally available food material, and by integrating several approaches to the detection of biological activities, advanced processing technology, an efficient distribution system and the effective use of bio-resources. The model was applied to the development of Tunisia, with olives and olive oil as the 'seeds for industrialization'. Various biological activities, for instance anti-oxidation, anti-pathogen and anti-inflammation properties, have been detected in the components of Tunisian olive and aromatic plants using the bioassay screening system. For food processing and efficient distribution, we noted the new technology of MC emulsification and considered it as a new development in the production of foods. As an effective use of bio-resources, inedible lipids were proposed as a more sustainable material for the production of biodiesel fuel, taking into consideration the balance of energy input and $CO_2$ emission for bioenergy production. This integrated approach would make it possible to design and construct a model of regional development based upon innovation using ideas inspired by traditional products. The generation of a new line of innovation, using olives and olive oil as seeds of industrialization, expects to provide a new way to enhance productivity and competitiveness and to create employment in the local agro-food industry in North Africa including Tunisia.

## Annotation

A) The Euro-Mediterranean Partnership proposed an initiative to construct a zone of shared prosperity through an economic and financial partnership, and the gradual establishment of a free-trade area by the target date of 2010. Negotiations for Agreements already concluded include those with Tunisia in 1995, Morocco in 1996, Algeria in 2002 and Egypt in 2004. See the Euro-Mediterranean Partnership-Overview, cited by http:// ec.europa.eu/external_relations /euromed/ index.htm [Accessed 30 January, 2009].

B) In most of the economies of North Africa, the contribution of technological progress to economic growth remains underdeveloped. Total Factor Productivity (TFP) as an indicator of technological change contributed less than capital accumulation to accounting for growth from 1960 to 1998 (Abu-Qarn and Abu-Bader, 2005). It is, therefore, how economies in North Africa induce innovation without greatly depending upon capital accumulation, and shift to the knowledge-based development path that will be crucial to attaining sustainable economic development.

## References

Abaza L., Talorete T.P.N., Yamada P., Kurita Y., Zarrouk M., Isoda H.(2007): Induction of Growth Inhibition and Differentiation of Human Leukemia HL-60 Cells by a Tunisian Gerboui Olive Leaf Extract. *Bioscience Biotechnology Biochemistry*, **71**(5): 1306-1312.

Abu-Qarn A, Abu-Bader S. (2007): Sources of Growth Revised: Evidence from Selected MENA Countries. *World Development*, **35**(5): 752-771.

Isoda H. (2008): *Protocol Collection of Bioassay Systems for the Development of Bioresources*. Alliance for Research on North Africa (ARENA), University of Tsukuba.

Japan Tariff Association (2007): *Japan Export and Imports: Commodity by Country 2006*.12, March.

Kawano M., Matsuyama K., Miyamae Y., Shinmoto H., Kchouk M., Morio T., Shigemori H., Isoda H. (2007): Antimelanogenesis effect of Tunisian herb *Thymelaea hirsute* extract on B16 murine melanoma cells. *Experimental Dermatology*, **16**: 977-984.

Yamada P., Zarrouk M., Kawasaki K., Isoda H. (2008): Inhibitory effect of various Tunisian olive oils on chemical mediator release and cytokine production by basophilic cells. *Journal of Ethno-pharmacology*, **116**: 279-287.