RESEARCH ARTICLE

Intercontinental Research Partnership in Food Sciences

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ABSTRACT

Food around the world is prepared and eaten in various ways. However, health and safety plays a major concern regardless of how the food is processed and eaten. Food safety standards and codings give reassurance in food imports and exports. Food imports and exports partnership could influence the tendency of between countries collaboration in food science and/or nutritional researches. The behaviour of between countries collaboration is hypothesised to be related with the continents economic status. Online survey was conducted to analyse the differing levels of research partnership between countries by categorising the countries into six main continents – Africa, Asia, Australiasia, Europe, North America and South America with the economic status of the country being divided into either high, medium or low. The majority of the articles represented research done through partnerships of countries come from same income level. The least-utilised partnership was that among countries from different income levels. The findings obtained from the current study indicate limited cooperation in global food science research. Therefore there is need to explore ways of increasing such research collaborations.

INTRODUCTION

Research collaboration has been identified as a key requirement in science productivity leading to emphasis on the need to collaborate both at individual and institutional levels. For instance, Pravdic and Oliuic-Vukovic (1986) in analysing collaborative patterns in chemistry observed that scientific output was closely dependent on the frequency of collaboration among authors while Kahi*et al*. (2006) when looking at international research partnerships in relation to topics in animal breeding and genetics noted that collaboration can be used to achieve development goals especially where the collaboration involves countries in different income categories. Research collaboration occurs in different academic disciplines due to different reasons. They include the complexity associated with some research due to their multidisciplinary dimension, cost implication, government policies among others (Beaver and Rosen, 1979).

Despite the benefits afforded by research collaboration there is no evidence that it exists in food sciences and its global extent. The current research was

thus aimed at (i) to investigate the existence of research collaboration in areas of food sciences and (ii) evaluating the extent of the collaboration amongst the world continents.

MATERIALS AND METHODS

An online survey was conducted on five different previously published food science and/or nutritional science journal articles in 2008. The journals were selected based on geographical representation to capture a well-balanced global distribution. They each came from Africa (African Journal of Food Science), Asia (Asian Journal of Food and Agro-Industry), Australasia (Nutrition & Dietetics), Europe (Food Science and Technology) and America (Food Science Journal). A total of 794 articlesfrom2801 authors in 61 countries were grouped based on the location of authors' institutes (countries), subject contexts and income economies of the countries.

Articles were broadly categorized into seven groups with the code and definition as shown in Table 1. For each article, country names of all the authors, the number of

Table 1: Key article categories identification from five food science journals

Code	Category	Definition
C	Food chemistry	Chemical changes in foodstuff, food additives; chemistry of modification of food ingredients or components to improve functionality and nutritional quality.
E	Food Engineering, Technology and Physical Properties	Genetically modified food, shelf life determination, food processing and technology.
M	Food Microbiology	The implication of beneficial microbes into foodstuff, isolate food spoilage bacteria and the determination and cultivation of different strains in products.
S	Sensory and Food Quality	The development of sensory analysis through five sensory properties. Research related to quantitative and subjective assessments of food quality.
H	Health and Nutrition	The development of food for therapeutic usage and the determination of nutritional values of varying food sources. Research that integrates food science and technology with applied personal and public health nutrition.
T	Toxicology and Chemical Food Safety	Determine potential food toxicity from microbes, chemical and physical origin, and the assessment of HACCP or similar food safety programs.
R	Concise Reviews and Hypotheses	Discuss past studies on important topics, and hypothesis manuscripts are appropriate in pioneering areas of research or important areas that are impacted by scientific controversy.

authors, the year, the volume number, and the title page were collected. The continental source of the collected information was used to determine the geographical context of the article. All authors from each article were categorized into six continents based on their countries' location (The World Bank, 2009a), to provide data of full authorship of articles. Only the first author was used to decide the origin (country) of the article.

Based on the authorship analysis, the origin of the author was considered to identify the nature of research partnership which in this study were categorised as Low income-Low income (LL) partnerships defined as cooperation between and within low income countries; Middle income-Middle income (MM) partnerships defined as cooperation between and within middle income countries; High income-High income (HH) partnerships defined as cooperation between high income countries; Low income-Middle income (LM) partnerships defined as cooperation between and within low and middle income countries; Low income-High income (LH) partnerships defined as cooperation between and within low and high income countries; and Middle income-High income (MH) partnerships defined as cooperation between and within middle and high income countries. Low income-Middle income-High income (LMH) partnerships defined as cooperation between and within low, middle income and high income countries.

The categorization into various income countries was based on The World Bank(2009a): low income = $935 or less gross national income per capita, middle income = $936 to $11455 gross national income per capita, high income = $11456 or more gross national income per capita. Although all authors from each article were recorded; only the first author, second author and last author were used to determine the research partnerships. In articles with authors from the same income level countries were classed as an LL, MM or HH partnership. Two authors from different income level countries were classed as an LM, MH or LH partnership; depending on where their countries' income levels were. With authors from three different income level countries, an LMH partnership was classed.

Data were analyzed using Gen stat (12.2). Analyses were performed to determine the association between the various categories in food science/nutrition and continental representation and nature of the research partnership. Linear regression was conducted to test the relationships between the total research partnership and the research partnership from each category.

RESULTS AND DISCUSSION

Figure 1 show results for food science articles authorship by continent for the selected journals with Asia having the highest and Africa least. North America contributed approximately one-fourth of the articles. South America produced less than 1% more articles than Africa at 6.57% contribution. Based on five surveyed journals, the least of the research articles was from Africa. Beintema and Stads (2004) reported that the food related research and development in Africa is slowly growing in the beginning of 21st Century, this mainly due to fewer investments per scientists, less international support and shortage of scientists. The World Bank (2009b) observed that more investments, especially in public funding could accelerate research performance in African countries.
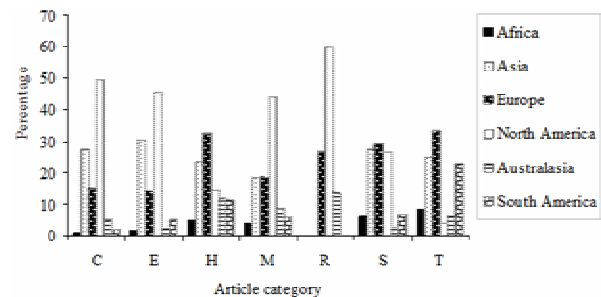
Fig. 1: The frequency of continental contribution on category basis

As indicated in the results Australasia, Europe and North America continents contributed to all categories though at varying levels with North America contributing the bulk of articles in concise reviews and hypothesis (approximately 60%) while Africa and Asia contributed no articles for the journals considered in this category. It has been well documented the importance of food quality for human consumption (Vernile et al. 2009). In all cases, Africa contributed the least to most research categories in exception of toxicology and chemical food safety, sensory and food quality.

Table 2: Articles in each category and by the nature of the research partnership

Category	%							Total[1]
	L-L	M-M	H-H	L-H	L-M	M-H	H-H+M-M	
H	3.28	28.96	64.48	0.00	0.00	3.28	32.24	183
E	2.89	35.84	55.49	0.58	0.00	5.20	38.73	173
C	3.18	29.94	57.33	0.64	0.00	8.92	33.12	157
S	0.00	30.17	64.66	0.00	0.00	5.17	30.17	116
M	0.98	21.57	69.61	0.00	0.98	6.86	22.55	102
T	6.25	22.92	64.58	0.00	0.00	6.25	29.17	48
R	0.00	13.33	86.67	0.00	0.00	0.00	13.33	15
Total	2.52	29.22	62.22	0.25	0.13	5.67	91.44	794

[1]Number of papers from each category

Table 2 presents results for food research category distribution of the surveyed articles. Out of the total publication health and nutrition category contributed most. The least was from concise reviews and hypothesis with only 15 articles. This survey showed that category of Health and Nutrition received the most attention, with approximately 23% of the total articles surveyed. The Health and Nutrition finds importance in modern food production system and public food consumption due to the growing awareness amongst the burgeoning middle class across the world.

Research partnerships amongst different countries within continents were also presented in Table 2. The HH partnership was dominant across all categories, covering 62.22% of research articles. However, research partnership between low, medium and high income economies (LMH) and low and medium (LM) counterparts was weak or not existing. The MM partnership contributed 29.22% across all categories. Within-category comparison showed that HH partnership produced the most articles; followed by MM partnership. Around 87% to 100% articles from different categories were constituted by HH and MM partnerships. The LL partnership produced the most articles in the category of toxicology and chemical food safety (6.25%) in addition of having a 2.52% of all the partnerships. This could be explained by observation made he World Bank (2009b) and Duque *et al.* (2005), which pointed out that the investments in low income countries research and development is limited. The LH partnership only produced articles in food engineering, technology and physical properties; and food chemistry. Partnerships from different income economies (LM, LH, MH or LMH) were limited, with a maximal level of 5.67% from MH.

The HH seem to partner in research more with other countries within the same category respectively. This has been demanded by the similarity of challenges faced by food producers in countries within the same category. Usually research partnerships between same income level countries are formed to solve research problems that are common in both countries. Similar partnership has been showed for MM. Frame (1979) and Luukkonen *et al.* (1992) observed that difference in levels of income, geography location, lifestyle, language, infrastructure, and political background has important influence in research partnership which has further been confirmed by current findings. Kahi*et al.* (2006) emphasized that partnerships from different income levels can result in sound research and development goals.

From the results, there was an observable continental prioritisation of research categories in the current study. For instance, Africa contributed a large number of articles on Toxicology and Chemical Food Safety categories, suggests that advocates of food safety are concentrated in the Africa continent where public health safety and hygiene are the main issues of Africa countries. Mengu (2003) pointed out that "A constant health threat in most African countries is the frequent outbreak of food-borne pathogenic diseases". The continental prioritization of research categories indicates that certain food related problems may be more of a concern in one region as opposed to another. This could be used to explain the trend observed in partnership amongst different income countries. It would be expected that countries in Asia continent would have more in common in the need to research in food science than with their counterpart in South America. Furthermore food has cultural orientation making people within a region having more to share than would be across cultures (Luukkonen *et al.* 1992).

Conclusion and recommendations

This survey has showed evidence about research partnerships in food science. The majority of the articles represented research done through partnerships of countries come from same income level. The least-utilised partnership was that among countries come from different income levels. Research partnerships across the whole world among different income level countries are critical. It improves the efficiency of utilising facilities and applying new concepts. In addition, it stimulates broader research area internationally overall. This survey indicates a short of global food science cooperation, and should serve as an incentive and justification for more focused efforts on increasing levels of scientific cooperation between researchers from countries with different income levels.

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