# Chapter 7

## Microbiological safety and quality of fish and fishery products

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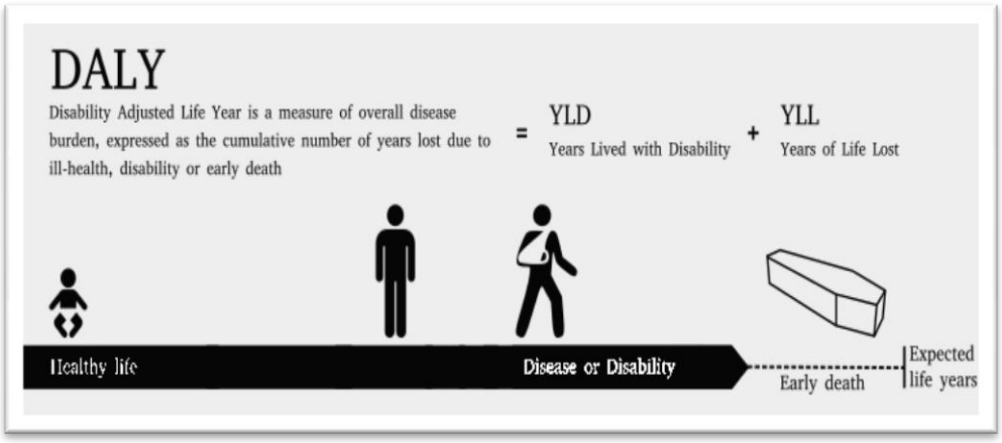
The continued occurrence of foodborne illness is not evidence of the failure of our food safety system. In fact, many of our prevention and control efforts have been and continue to be highly effective. In advanced countries like US where food supply is one of the safest in the world, however, significant food borne illness continues to occur. Despite great strides in the area of microbiological food safety, much remains to be done. In under developed and developing countries of Asia, Africa and Latin American Countries in the absence of good surveillance programs the task is much more complicated especially catering to needs of microbial safety of foods of billions of populations.

Food-borne disease outbreaks are defined as the occurrence of 2 or more cases of a similar illness resulting from ingestion of a common food or observed number of cases of a particular disease exceeds the expected number. These can be confirmed (when at least one causal agent is identified) or suspected (based on clinical and epidemiological information). Although most cases are sporadic, these diseases draw attention to themselves due to outbreaks, thorough investigation of which can help in identifying control measures.

Annual burden of foodborne diseases in the WHO South- East Asia Region includes more than: • 150 million illness • 175 000 deaths • 12 million DALYs Source: FERG Report 2010

The disability-adjusted life year (DALY) is a measure of overall disease burden, expressed as the number of years lost due to ill-health, disability or early death. It was developed in the 1990s as a way of comparing the overall health and life expectancy of different countries.

The DALY is becoming increasingly common in the field of public health and health impact assessment (HIA). It "extends the concept of potential years of life lost due to premature death...to include equivalent years of 'healthy' life lost by virtue of being in states of poor health or disability." In so doing, mortality and morbidity are combined into a single, common metric.




Despite significant success at improving the safety of the food supply, current science on which safety is based does not sufficiently protect consumers from emerging issues inherent to a complex food supply. The evolving characteristics of food, technology, pathogens and consumers make it unlikely the marketplace will be entirely free of dangerous organisms at all times for all consumers. This is the conclusion made in the report, Emerging Microbiological Food Safety Issues: Implications for Control in the 21st Century was released today at IFT's International Food Safety and Quality Conference and Expo in Atlanta one and half decades back.

The report, drew upon experts specializing in food borne pathogens and microbial evolution, food borne illness, food production and processing, testing methods and regulatory measures, reveals that diligent adherence to current methods that create and monitor the food supply cannot eliminate the risk of food borne illness. The report also offered the recommendations for providing the greatest possible reduction in food safety risks.

**Among its seven important issues addressed were**:

1. Procedures from farm to table to significantly reduce illness due to mishandling,
2. Processes to recognize and respond to outbreaks and to reduce their scope.
3. Poor habits that make consumers more susceptible to foodborne illness,
4. Education and training recommendations necessary for reducing pathogenic influence at every step
5. From production to consumption (pond to plate/farm to fork
6. Recommendations to enhance monitoring, data generation, and risk assessment. &
7. The current state and future potential of rapidly evolving illness-causing pathogens and other key issues.

To gain the greatest measure of food safety, the report stressed on the necessity of implementing flexible food safety measures so as to utilize as quickly as possible the latest scientific information as it evolves. The report also urged manufacturers, regulatory and public health agencies and allied organizations to develop partnerships to improve risk assessment and food safety management.

**SEAFOOD SAFETY GOALS MUST ACHIEVE MORE THAN END-PRODUCT PROBES**

The absence of pathogens in final-product testing does not ensure food free of virulent microorganisms, according to a new expert report on food safety issues, and as pathogen contamination decreases this form of testing becomes more deficient. So as today's food safety continues to improve, more emphasis should be placed on monitoring processing capabilities and conditions through the application of science-based food systems.

The microbiological testing of finished sea food products and can be misleading for the following reasons

1. Due to statistical limitations based on the amount of product sampled,
2. The percentage of product contaminated, and
3. The uniformity of the contamination distributed throughout the food.

The above mentioned negative results imply an absence of pathogens in foods, the report states, and can cause consumers to assume proper food selection and handling practices are unnecessary. Instead, the report urges everyone along the farm-to-fork seafood chain to be responsible for an important role in food safety management.

According to Douglas L. Archer of the University of Florida who contributed to IFT report "Current safety evaluations focus on microbes that may or may not be harmful to humans," he added, "For example, some subtypes of *Listeria monocytogenes* found in or on food may not be associated with food borne illness. Yet their mere detection can be grounds for legal action against the manufacturer and force recalls of food that is unlikely to cause illness in the general population."

The need science-based approach called Food Safety Objectives that would place specific values on public health goals, with reassurances those values are reached at key points along the pond to plate process. Those values would be flexible as hazards and public health goals change, science progresses, and unfettered data sharing improves, allowing for the quickest implementation of new safety improvements as they evolve, and a safer food supply.

The report urges intentional interaction of public health, regulatory, industrial and consumer agencies, calling the implementation of a flexible, science-based approach involving all these parties "as the best weapon against emerging microbiological food safety issues."

**Steps in seafood Safety Management**

Foodborne illness in India is a major and complex problem that is likely to become a greater problem as we become a more global society where every $5^{th}$ person walking on this planet is going to be Indian. Nearly 10 million foodborne illnesses occur per year in India. To adequately address this complex problem, the need is to develop and implement a well-conceived strategic approach that quickly and accurately identifies hazards, ranks the hazards by level of importance, and identifies approaches for microbial control that have the greatest impact on reducing hazards, including strategies to address emerging hazards that were previously unrecognized.

**Policy Development**

Scientific research has resulted in significant success in improving seafood safety, but the current science supporting the safety of our seafood supply is not sufficient to protect us from all the emerging issues associated with the complexity of the food supply. As new issues emerge, some will be best addressed through the application of control technologies during seafood production and processing, but others may be best addressed at the consumer level through modification of exposure or susceptibility.

Food safety policies should be developed as part of national initiatives, with input from all stakeholders. In addition, international coordination of food safety efforts should be encouraged. Globalization of the food supply has contributed to changing patterns of food consumption and food borne illness, and global food trade has the potential to introduce pathogens to new geographic areas.

To achieve the maximum benefits, our food safety efforts and policies must be carefully prioritized, both in terms of research and in application of controls. As scientific advances provide a better picture of pathogenicity, the need of the hour is whether to focus the efforts on those pathogens that cause many cases of minor illness or instead focus on those pathogens with the greatest severity, despite the relatively low number of cases. In the move toward making decisions based on risk, the food safety policies need to weigh these issues, and communicate information about risk to all stakeholders, especially the public.

The body of scientific knowledge must be further developed, with the research efforts carefully prioritized to yield the greatest benefit. Food safety and regulatory policies must be based on science and must be applied in a flexible manner to incorporate new information as it becomes available and to implement new technologies quickly. The seafood industry, regulatory agencies and allied professionals should develop partnerships to improve food safety management.

**In essence**:

Seafood Supply and exports: The amount of exported seafood has increased significantly, and this trend is likely to continue. Consistent, widespread application of food safety systems, including Hazard Analysis and Critical Control Points systems and good manufacturing (GMP), must be encouraged for international trade.

New Seafood Processing Technologies and Novel sea foods. Scientists continue to be challenged to adequately address all the parameters associated with the introduction of a novel seafood or alternative processing technology. Once developed, new technologies must be appropriately used and regulated to ensure their proper application and the product's safety.

Increases in Organic Foods. The use of manure as a fish pond fertilization is a significant concern. Methods are needed to reduce the presence of pathogens in manure and to effectively eliminate them before they contaminate the aquatic environment and fish.

Changes in Food Consumption. People's changing dietary patterns affect their risk of foodborne illness. The control and prevention methods will need to be adapted to these

changing dynamics. For example, in India the number of high end consumers who prefer ready to eat foods are more than 300 million which is more or less equivalent to Europe.

At-Risk populations. It is likely that the number of persons at higher risk for foodborne disease will continue to increase with time. The population of India is going to be 150 crores. In addition, there are an increasing number of transplant recipients, people undergoing treatment for cancer, people with AIDS, and others with compromised immune system function.

Pathogen Evolution. Microbial evolution has always happened and will continue to occur. Improved surveillance and new genomic technologies offer the potential to identify new potential foodborne pathogens before they cause significant illness. Another hope for the future is a better understanding of how human actions affect foodborne pathogens.

Consumer Understanding. Education and risk communication will be necessary to share with consumers our growing knowledge of food safety risks and to encourage behavior modification, where needed.

Integrated Food Safety System. A farm to- fork or pond to plate table food safety system must involve many interested parties working together toward a common goal. The challenge is to build a system that applies science in a predictable, consistent, and transparent manner to enable harmonization within and between countries The list of principal symptoms of Bacteria, potential food contamination are provided in table below.

**List of bacterial food poisoning, symptoms and Food source**

| **Organism** | **Common Name of Illness** | **Onset Time After Ingesting** | **Signs & Symptoms** | **Duration** | **Food Sources** |
|---|---|---|---|---|---|
| *Bacillus cereus* | *B. cereus* food poisoning | 10-16 h | Abdominal cramps, watery diarrhea, nausea | 24-48 h | Meats, stews, gravies, vanilla sauce |
| *Campylobacter jejuni* | Campylobacteriosis | 2-5 days | Diarrhea, cramps, fever, and vomiting; diarrhea may be bloody | 2-10 days | Raw and undercooked poultry, unpasteurized milk, contaminated water |
| *Clostridium botulinum* | Botulism | 12-72 hours | Vomiting, diarrhea, blurred vision, double vision, difficulty in swallowing, muscle weakness. Can result in respiratory failure | Variable | Improperly canned foods, especially home-canned vegetables, fermented |

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|---|---|---|---|---|---|
| | | | and death | | fish, baked potatoes in aluminum foil |
| *Clostridium perfringens* | Perfringens food poisoning | 8–16 hours | Intense abdominal cramps, watery diarrhea | Usually 24 hours | Meats, poultry, gravy, dried or precooked foods, time and/or temperature -abused foods |
| *Cryptosporidium* | Intestinal cryptosporidiosis | 2-10 days | Diarrhea (usually watery), stomach cramps, upset stomach, slight fever | May be remitting and relapsing over weeks to months | Uncooked food or food contaminated by an ill food handler after cooking, contaminated drinking water |
| *Cyclospora cayetanensis* | Cyclosporiasis | 1-14 days, usually at least 1 week | Diarrhea (usually watery), loss of appetite, substantial loss of weight, stomach cramps, nausea, vomiting, fatigue | May be remitting and relapsing over weeks to months | Various types of fresh produce (imported berries, lettuce, basil) |
| *E. coli (Escherichia coli)* producing toxin | *E. coli* infection (common cause of "travelers' diarrhea") | 1-3 days | Watery diarrhea, abdominal cramps, some vomiting | 3-7 or more days | Water or food contaminated with human feces |
| *E. coli* O157:H7 | Hemorrhagic colitis or *E. coli* O157:H7 infection | 1-8 days | Severe (often bloody) diarrhea, abdominal pain and vomiting. Usually, little or no fever is present. More common in children 4 years or younger. Can | 5-10 days | Undercooked beef (especially hamburger), unpasteurized milk and juice, raw fruits and vegetables (e.g. |

| | | | | | |
|---|---|---|---|---|---|
| | | | lead to kidney failure. | | sprouts), and contaminated water |
| Hepatitis A | Hepatitis | 28 days average (15-50 days) | Diarrhea, dark urine, jaundice, and flu-like symptoms, i.e., fever, headache, nausea, and abdominal pain | Variable, 2 weeks-3 months | Raw produce, contaminated drinking water, uncooked foods and cooked foods that are not reheated after contact with an infected food handler; shellfish from contaminated waters |
| *Listeria monocytogenes* | Listeriosis | 9-48 h for gastro-intestinal symptoms, 2-6 weeks for invasive disease | Fever, muscle aches, and nausea or diarrhea. Pregnant women may have mild flu-like illness, and infection can lead to premature delivery or stillbirth. The elderly or immunocompromised patients may develop bacteremia or meningitis. | Variable | Unpasteurized milk, soft cheeses made with unpasteurized milk, ready-to-eat deli meats |
| Noroviruses | Variously called viral gastroenteritis, winter diarrhea, acute non-bacterial gastroenteritis, food poisoning, and food infection | 12-48 h | Nausea, vomiting, abdominal cramping, diarrhea, fever, headache. Diarrhea is more prevalent in adults, vomiting more common in children. | 12-60 h | Raw produce, contaminated drinking water, uncooked foods and cooked foods that are not |

| | | | | | |
|---|---|---|---|---|---|
| | | | | | reheated after contact with an infected food handler; shellfish from contaminated waters |
| *Salmonella* | Salmonellosis | 6-48 hours | Diarrhea, fever, abdominal cramps, vomiting | 4-7 days | Eggs, poultry, meat, unpasteurized milk or juice, cheese, contaminated raw fruits and vegetables |
| *Shigella* | Shigellosis or Bacillary dysentery | 4-7 days | Abdominal cramps, fever, and diarrhea. Stools may contain blood and mucus. | 24-48 h | Raw produce, contaminated drinking water, uncooked foods and cooked foods that are not reheated after contact with an infected food handler |
| *Staphylococcus aureus* | Staphylococcal food poisoning | 1-6 hours | Sudden onset of severe nausea and vomiting. Abdominal cramps. Diarrhea and fever may be present. | 24-48 hours | Unrefrigerated or improperly refrigerated meats, potato and egg salads, cream pastries |
| *Vibrio parahaemolyticus* | *V. parahaemolyticus* infection | 4-96 hours | Watery (occasionally bloody) diarrhea, abdominal | 2-5 days | Undercooked or raw seafood, such as |

| | | | | | |
|---|---|---|---|---|---|
| | | | cramps, nausea, vomiting, fever | | shellfish |
| *Vibrio vulnificus* | *V. vulnificus*infection | 1-7 days | Vomiting, diarrhea, abdominal pain, blood borne infection. Fever, bleeding within the skin, ulcers requiring surgical removal. Can be fatal to persons with liver disease or weakened immune systems. | 2-8 days | Undercooked or raw seafood, such as shellfish (especially oysters) |

**Need for Quality Improvement in Fish**

QUALITY ISO 9000:1989; ISO8402
DEFINITION: The Totality of Features and Characteristics of a Product or Service that Bear on its Ability to Satisfy Stated or Implied Needs

*QUALITY ISO 9000:2000 DEFINITION:*
Ability of Complete Set of Realized Inherent Characteristics of a Product System or Process to fulfil Requirements

| **Underutilization of conventional fish stocks (in million tons)** | | |
|---|---|---|
| Wet fish | Post-harvest losses | 2 |
| Cured fish | Post-harvest losses | 3 |
| By-catch | Discarded at sea | 5-20 |
| Pelagic fish | Used for fish meal | 20 |
| Pelagic fish | Under exploited | 20 |

| **Degree of losses under different climatic conditions** | | | |
|---|---|---|---|
| Loss causing agent | Dry (but possibly With overnight dew) | Humid | Rainy |
| Spoilage prior to Processing | Low | Low to moderate | High |
| Blowfly | Low | Moderate to high | High |
| Halophilic bacteria and molds | Low to moderate | Moderate to high | High |

| | | | |
|---|---|---|---|
| Beetle infestation | Moderate to high | Moderate | Low (relatively) |

| **Factors contributing to outbreaks of fish borne disease** | |
|---|---|
| Contributing factors | Percentage [a] |
| Factors relating to microbial growth | |
| Storage at ambient (room) temperature | 43 |
| Preparation too far in advance of serving | 41 |
| Improper warm holding | 12 |
| Use of leftovers | 5 |
| Extra large quantities prepared | 22 |

| **Factors contributing to outbreaks of fish borne disease** | |
|---|---|
| Contributing factors | Percentage [a] |
| Factors relating to microbial survival | |
| Improper reheating | 17 |
| Inadequate cooking | 13 |
| Factors relating to contamination | 12 |
| Food workers | 7 |
| Contaminated raw foods | 11 |
| Cross-contamination | 7 |
| Inadequate cleaning of equipment | 5 |
| Unsafe source | |

| **Food hazards: Perception of the consumer verses epidemiological data** | | |
|---|---|---|
| Case | Perception | Relative importance |
| Microbial contamination | 22 | 49.9 |
| Nutritional imbalance | | 49.9 |
| Environmental contaminants | 31 | 0.05 |
| Natural toxins | 10 | 0.05 |
| Food additives | 30 | 0.0005 |
| Others, e.g., packaging materials | 7 | |

| **Chlorine use in different stages** | |
|---|---|
| **Purpose** | **In PPM** |
| Washing for processing | 5-10 |
| For making ice | 5-10 |
| To disinfect after washing with detergents | 100 |
| Washing floor s and gutters | 500-800 |
| Washing product | 10 |
| Washing of boat deck, fish holds and wooden boxes. | 1000 |
| Cleaning of fish containers, carrier vans, refrigerated wagons | 100 |
| Washing of utensils, processing tables etc | 100 |
| washing of hands | 20 |

| **Spoilage characteristics of some dry salted fish products** | | |
|---|---|---|
| **Variety** | **Product** | **Spoilage type** |
| Tuna | Dry salted | Off –odour (OO) |
| Mackerel | -do- | Pink –discolouration (PD) |
| Seer | -do- | Halophilic bacteria |
| Horse mackerel | -do- | Free from PD & no OO |
| Shark | -do- | OO&PD |
| Thread fin | -do- | OO&PD |
| Cat fish | -do- | OO,PD, clinging salts |
| Prawns | Dried | OO |
| Bombay duck | laminated | Grey white colour, OO &PD |

***BASIC PRECAUTIONS TO IMPROVE QUALITY OF CURED FISH***

- Select good quality fish
- Clean the fish with freshwater
- Eviscerate the fish properly
- Select good quality salt

- Proper drying of fish need to be done
- Employ proper dryers
- Protect the fish adverse conditions: rain, birds, animals etc.
- Proper packaging and
- Proper storage

***TOOLS FOR QUALITY IMPROVEMENT***

- Empowerment
- Benchmarking
- Kaizen (Continuous improvement approaches)
- 6-Sigma applications
- 5-S A requirement for TQM
- Good manufacturing Practices (GMP)
- Hazard Analysis Critical Control Point (HACCP)

***5S GOOD HOUSEKEEPING***

- Sort: take out unnecessary items and dispose
- Systematize: Arrange necessary items in good order
- Sweep: Clean your work place
- Standardize: Standardize the process of sorting, arranging and cleaning
- Self-discipline: Do things spontaneously as a habit.

***EVOLUTION OF THE QUALITY PROFESSION***

- ’50s---Inspection & Conformance to specification
- ’60s---Customer requirements or fitness for use
- ’70s---Human dimensions of quality (Quality people do quality work)
- ’80s---Relationships at the work place (Quality work depends on quality of work life)
- ’90s--- partnerships between employees, customers and stakeholders.
- 2010: management of Data, Information and Knowledge

***5M’s of Quality***

- Manpower
- Materials
- Methods
- Machines
- Measurement

***5r’S OF UNQUALITY***

- Reject

- Rework
- Return
- Recall
- Regrets

***PPM OF QUALITY RESPONSIBILITY***

- Planning
- Prevention
- Monitoring

***DIFFERENT LEVELS OF QUALITY PRACTICE***

- LEVEL 1- QUALITY AWARENESS (QAW)
- LEVEL II- QUALITY CONTROL (QC)
- LEVEL III- TOTAL QUALITY CONTROL (TQC)
- LEVEL IV- TOTAL QUALITY MANAGEMENT (TQM)
- LEVEL V-PARTNERSHIPS FOR QUALITY, PRODUCTIVITY AND PROFITABILITY (PQP2)

***PRINCIPLES OF TOTAL QUALITY MANAGEMENT***

- A Aim for customer satisfaction
- C Communicate and coordinate allactivities
- C Commit and cooperate towards improvement
- E Empower the employees
- P Promote use of problems solving tools
- T Training for quality is forever

***STAGES IN TQM DEVELOPMENT***

- G Get management commitment
- R Review recorded procedures
- A Assess quality practices
- C Compare records and practice
- E Evaluate results

- O Overview total situation
- F Find areas requiring improvement

- G Get fully involved
- O Out do your own performance
- D Document changes in procedures

- A Assessment,identificationand preparation
- M Management, understanding and commitment
- E Energizing for improvement
- N New initiatives, new targets and critical monitoring

***REQUISITES FOR TOTAL QUALITY COMMITMENT***

- C Customer orientation whether inside or outside the set up
- H Human resource striving for excellence
- A Acquisition of products and process leadership
- M Management leadership for quality
- P Practice quality as a way of life inside and outside work place
- S Sustained quality culture in the company

***CARES***

- C Communicate management plans for quality
- A Accessibility to one another in the organization
- R Revitalization of problem solving capabilities
- E Embarrassments are avoided if all agree that inspection is not the way to achieve quality
- S Sustain the desire to personally commit to quality

***CODE OF CONDUCT IN TEAM MEETING***

- Cooperate with each other
- Listen to other's ideas
- Keep an open mind
- No personal attacks
- Stick to the facts
- Every one participates
- Be tactful, be honest
- No hidden agendas

***IMPORTANCE OF DELIVERING BOTH QUALITY PRODUCTS AND SERVICE***

- 68% customers stop purchases due to poor service
- Customers are five times more likely to leave for poor service than poor product quality or high cost
- The average unhappy customer tells nine other people about experience
- When 50 to 75% of the complaints attended to 95% unhappy customers can be saved
- Average happy customer tells five other

**Costliest Tuna as case study**

Kiyomura Co's sushi chefs react to a part of a 222 kg (489 lbs) Bluefin tuna after cutting its meat at the company's sushi restaurant outside Tsukiji fish market in Tokyo January 5, 2013. The tuna was sold nearly for 1.8 million USD and when it converted into local currency what could be cost of whole of 222kg, per/kg and also with 74% meat amounting to 164.28kg and per kg of the same is provided in the Table below.

| Costliest Bluefin Tuna sold for 1.8 million USD and when it is converted into local currency what could be cost of whole of 222kg, per/kg and also with 74% meat amounting to 164.28kg and per kg | | | | | | |
|---|---|---|---|---|---|---|
| S. No | Country (currency) | Local currency to USD | USD to local currency | A 222Kg Bluefin tuna cost | Per Kg out of 222kg | With 74% meat yield ratio 164.28 weight cost per/kg |
| 1 | Afghanistan (Afghani) | 75.97 | 0.013 | 136,746,000 | 615,972.97 | **832,395.91** |
| 2 | Algeria (Dinar) | 118.61 | 0.0084 | 213,498,000 | 961,702.70 | **1,299,598.25** |
| 3 | Bangladesh (Bangladeshi Taka) | 83.79 | 0.012 | 150,822,000 | 679,378.37 | **918,078.88** |
| 4 | Guatemala (Guatemalan Quetzal) | 7.69 | 0.13 | 13,842,000 | 62,351.35 | **84,258.58** |
| 5 | Malawi (Malawi kwacha) | 727.22 | 0.085 | 1,308,996,000 | 5,986,378.37 | **7,968,078.88** |
| 6 | Mauritius (Mauritian rupee) | 34.47 | 0.029 | 62,046,000 | 279,486.49 | **377,684.44** |
| 7 | Oman (Oman Rial) | 2.60 | 0.38 | 684,000 | 3081.08 | **4163.22** |
| 8 | Sri Lanka (Sri Lankan rupee) | 175.13 | 0.0058 | 315,234,000 | 1,419,972.97 | **1.918,882.39** |
| 9 | Sudan (Sudanese pound) | 47.62 | 0.021 | 85,716,000 | 386,108.10 | **521,767.71** |
| 10 | Syria (Syrian Pound) | 514.93 | 0.0019 | 926,874,000 | 4,175,108.11 | **5,642,037.98** |
| 11 | Tanzania (Tanzania Shilling) | 2290.40 | 0.00044 | 4,122,720,000 | 18,570,810.81 | **25,095,690.28** |
| 12 | Tunisia (Tunisian | 2.91 | 0.034 | 5,238,000 | 23,595.00 | **31,884.59** |

| | | | | | | |
|---|---|---|---|---|---|---|
| | Dinar) | | | | | |
| 13 | Uganda (Ugandan Shilling) | 3766.70 | 0.00027 | 6,780,060,000 | 30,540,810.81 | **41,271,365.96** |
| 14 | Zimbabwe | 361.9 | 0.002763 | 651,420,000 | 2,934,423.32 | **3,965,303.14** |